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**Additions to The Electrical World's Forces.** MANY tasks need many hands to accomplish them, and it is a pleasant thing to chronicle the success that demands additional energies. Owing to the unprecedented growth of the business that must be handled by THE ELECTRICAL WORLD several well know gentlemen have been added to the working staff of the office. Mr. Fred De Land, widely known as the Western representative of the paper, has been transferred to the home office to take an active part in the development of rapidly growing interests; Mr. William Hazen, for some years the assistant publisher of the *Evening Post*, and Col. J. Frank Dillont, long intimately connected with the management of the *Independent*, have also come to add their long experience and often recognized executive abilities to the management of the business department of THE ELECTRICAL WORLD. The many friends of the paper will welcome them cordially and join with us in the pleasure we take in recording their coming, and the prosperity that foreruns and will follow it.

**The Unit of Inductance.** THE paper by Mr. A. E. Kennelly, published in another column, contains, apart from an interesting explanation of the nature of inductance, a large amount of experimental data that it is quite impossible to find elsewhere. The resistances of all ordinary forms of apparatus are matters of every-day knowledge, but strange to say, until this research appeared it would have been hard to find an electrician who could give even an approximate estimate of the self-induction of a single instrument or machine. Even those most intimately acquainted with alternating current practice rarely measure the induction coefficients of the apparatus they are using, and have no very definite idea of its real magnitude. It is really not a difficult thing to measure inductance, and it is far too important a factor in alternating current work to be neglected. We hope the paper before us will stimulate many to study the subject and acquaint themselves with its practical side. As for the proposed unit of inductance, the name that has been proposed seems to be rapidly working its way into the general use it deserves, and ere long the henry should be as familiar an acquaintance as the ohm. It is peculiarly fitting that the discoverer of self-induction should have his name perpetuated in the designation of the unit selected for its measurement, and the proposition that has been made needs no further recommendation.

**The Electrical World for 1891.** WITH the present number closes the sixteenth volume of THE ELECTRICAL WORLD, and it gives us pleasure, in ending the volume and the year together, to greet our many friends, and wish them as good fortune in the coming months as they could desire or hope. Next year THE ELECTRICAL WORLD will call upon them dressed in garments somewhat smarter than heretofore. The old brown overcoat that has seen so much service will be laid aside, and its place will be taken by a new cover of slightly different color, rather brighter and neater, we think, than the one discarded. We have also secured a new hat, and we flatter ourselves that a glance at the heading of Vol. XVII., No. 1, will convince the observer that it is more becoming than the old one ever was. In addition—but we will not press the analogy further—suffice it to say that within the cover some changes—improvements we hope—will be noted. The paper will be of somewhat better quality, the illustrations more artistic, and the typography more finished. In the arrangement, it has been found desirable to make a special department of the electric railway and also of the electrical stock market. Aside from these slight changes our readers will find THE ELECTRICAL WORLD the same old friend, with both eyes wide open for every thing that can interest them, and always ready to do them a good turn whenever it is possible. A Happy New Year!

**Electric Lighting Stations.** IT is somewhat of a revelation to glance over the items recorded in our news columns and note the great number of lighting installations that have been made during the present year. The increase in this department has been second only to the marvelous growth of the electric railway. It is very difficult to get exact statistics of the work of the year, but a conservative estimate would place the increase in the number of incandescent lamps in regular service at something like half a million, while the number of arc lights has probably risen at least twenty-five thousand. Even the smaller towns, particularly throughout the West, are rapidly falling into line, and have come to look upon the electric light not as a luxury but as a necessity. It is safe to predict that the coming year will show increases even more startling. People are rapidly coming to realize what good illumination is, and to recognize the only means by which it can be attained. And the best of it is that the almost innumerable electric light stations seem to have been blessed with a most remarkable degree of prosperity. They have been shown to be good investments, and there is very little difficulty in persuading capital of the fact. The time is coming when electric lights will be within reach of every one who cares to use them, and as the people who do not are mostly moribund or purblind, we may confidently look for the supremacy of electric lighting at no distant date.

**Universal Electricity.** FEW, even among those most closely identified with the development of electrical theory and practice, fully realize how profoundly the discoveries of the past two or three years have affected the general views once held regarding electricity, and how wonderfully they have broadened the scientific ideas concerning the correlation of physical forces. It was a marvelous advance when Franklin discovered the identity of the feeble sparks that crackle from an electrified body with the colossal power of the thunderbolt, but what adequate words can be found to express the feeling akin to awe that comes when now at last we recognize the same mysterious something—perhaps an entity, possibly only a state—in the clear brilliancy of the sunbeam, the soft gleam of its reflection in the moonlight, the innumerable glowing sparks that glorify a winter's night? What can we think when we realize that every time a candle is lighted, or a lump of coal thrown upon the fire, electrical energy is produced just as truly as when a powerful battery is put into action, or the whirring belt spins the armature of a dynamo. And yet such is the fact. Whenever and wherever what we call light and heat are found, there is the same electromagnetic radiation that the brilliant speculation of Maxwell imagined, and the magnificent experiments of Hertz have brought within the realm of human knowledge. Radiant energy is electromagnetic energy—perhaps it is nothing more. Light, heat, actinism, coexist with and through electrical action. So far from having to seek through laborious research methods of producing electrical energy, it is hard to imagine any mechanical action, or in fact any material movement, that does not send it on its ceaseless journey through space. Electrical effects seem to be the rule instead of the exception, and we find to-day that what we call electricity is so closely co-ordinated with more familiar things that one can scarcely doubt that we are on the eve of some tremendous generalization that may make the last decade of this century memorable through all time.

**A Colossal Power Station.** ON other pages will be found illustrations and a full page description of the great power station of the Rochester Street Railway. This company, as is well known, adopted the Short apparatus, and consequently the station is quite unique in its equipment. It is not yet entirely completed, but will be ere long, and with the exception of the gigantic plant of the West End Street Railway in Boston will be the largest power station in the country. A portion of the railway system is already in operation, and the equipment is doing admirable work. Starting as it did with the series system of distribution, the evolution of the Short apparatus into its present form is somewhat remarkable. The form of armature adopted is unique among street railway motors and possesses the striking merit of being very unlikely to burn out. For high potential motors that are likely to be subjected to extraordinary strains without warning the Gramme armature is particularly well adapted, and it is a wonder that it has not been more generally in use. The Short generators are built on exactly the same general plan as the motors, and may indeed be regarded as a modification of the Brush type of dynamo. Both machines have in common the peculiar flat ring armature and a similar arrangement of the magnetic circuit. The engine equipment of the Rochester power station will be an instructive one to study as it includes both simple and compound engines of the same make. Working thus side by side their relative economy will make itself evident at once, and it is needless to say that the compound machine will have the advantage. Indeed at present the question is not between simple and compound engines for central station use, but between high and low speed machines of the latter type. The plan of arrangement followed at Rochester is one admirably suited to a situation where a considerable space may be occupied, and is probably the preferable plan whenever the quarters are not too severely crowded. Direct belting of engines to the dynamos possesses too many advantages to be disregarded, although it may sometimes be difficult on account of cramped quarters. All in all the Rochester power station is an admirable specimen of careful engineering, and is worthy thorough study on the part of those interested in similar enterprises.

**The London Electric Underground.** THE public opening of the underground electric railway, noted in our cable dispatch this week, may be fairly said to mark an epoch in the advance of the art of electric traction. In spite of the rapid growth of the electric street railway in this country, it has been reserved for our English cousins to display their splendid enterprise by inaugurating the use of electricity for railway service on a grand scale. We shall watch with the greatest interest the practical operation of the electric underground, more with the idea of learning the details of its success than from any hesitancy in accepting the promises it has already given. There is every reason to believe that it will more than fulfill the expectations of its promoters, for it has been carefully planned and conscientiously executed, with the superintendence of the best engineering skill that England can produce. Occasional difficulties there may be, for no system of such magnitude and novelty can be entirely free from them; yet it will be most surprising if the experience of a few months does not secure the elimination of the weak points that may present themselves. The traffic is so large that it will severely test the powers of the locomotives, and, indeed, every portion of the apparatus, but at the same time it gives promise of magnificent financial success. Such a suburban road is, from the point of view of the capitalist, the most favorable place to test the capabilities of any new system of rapid transit. While this assumption is quite correct when positive profits are to be considered, it must be remembered that electrically the operation of such a system is more difficult than high-speed work over long railway lines. If the problem of constructing an electric locomotive for suburban service has been successfully solved, a long step will have been taken toward displacing steam on ordinary railroads. As the speed to be attained increases, the relative economy of electric traction becomes rapidly greater, and the electrical difficulties grow decidedly less. Let this English enterprise be an object lesson to American engineers and railway managers, from which they may learn the possibilities of the coming century. The coming decade will in all probability see the period of preliminary experiment past once for all, and the promises of the year 1890 more than fulfilled.

## Latest Foreign Electrical News.

*(By Cable from our Regular Correspondent.)*

LONDON, Dec. 22, 1890.—Thursday, Dec. 18, the City & South London Railway was opened for regular business, and the trains began running, giving a five-minute service. The new enterprise has evoked great enthusiasm, and the traffic so far has been enormous. On Friday a heavy snow almost stopped the omnibuses upon which South Londoners largely depend, and the electric underground system was given an admirable opportunity of exhibiting its good qualities. The trains make considerable noise in spite of the electrical method of traction, and the operation of the system might be somewhat improved. The lighting of the cars is rather indifferent in quality, as the variations in voltage caused by changing the demands for current produce considerable variation in the light.

The contract for lighting the western district of this city has been awarded to the Brush Company. Another large lighting enterprise is proposed by the Bristol City corporation. It includes the erection of a station with a capacity of 10,000 incandescent lamps and 60 arcs.

## Moonlight Tables for January, 1891.

Herewith we give Mr. H. W. Frund's table of lighting hours for the month of January, under his modified form of moon schedule.

*Schedule for January*, 1891.

| | TABLE NO. 1. Standard Moonlight Philadelphia System. | | | TABLE NO. 2. Frund's New Moonlight System. | | | |
|---|---|---|---|---|---|---|---|
| Date. | Light. | Date. | Extinguish | Date. | Light. | Date. | Exting. |
| 1 | 5:15 P.M. | 1 | 11:55 P.M. | 1 | 5:15 P.M. | 1 | 12:00 M. |
| 2 | 5:15 | 3 | 12:55 A.M. | 2 | 5:15 | 3 | 12:55 A.M. |
| 3 | 5:15 | 4 | 1:55 | 3 | 5:15 | 4 | 1:55 |
| 4 | 5:20 | 5 | 2:55 | 4 | 5:20 | 5 | 2:55 |
| 5 | 5:20 | 6 | 4:05 | 5 | 5:20 | 6 | 4:05 |
| 6 | 5:20 | 7 | 6:25 | 6 | 5:20 | 7 | 6:25 |
| 7 | 5:20 | 8 | 6:25 | 7 | 5:20 | 8 | 6:25 |
| 8 | 5:20 | 9 | 6:25 | 8 | 5:20 | 9 | 6:25 |
| 9 | 5:20 | 10 | 6:25 | 9 | 5:20 | 10 | 6:25 |
| 10 | 5:20 | 11 | 6:25 | 10 | 5:20 | 11 | 6:25 |
| 11 | 5:25 | 12 | 6:25 | 11 | 5:25 | 12 | 6:25 |
| 12 | 5:25 | 13 | 6:25 | 12 | 5:25 | 13 | 6:25 |
| 13 | 5:25 | 14 | 6:25 | 13 | 5:25 | 14 | 6:25 |
| 14 | 9:00 | 15 | 6:25 | 14 | 5:25 | 15 | 6:25 |
| 15 | 10:10 | 16 | 6:25 | 15 | 5:25 | 16 | 6:25 |
| 16 | 11:10 | 17 | 6:25 | 16 | 5:25 | 17 | 6:25 |
| 17 | | | | 17 | 5:25 | 17 | 12:00 M. |
| 18 | 12:30 A.M. | 18 | 6:20 | 18 | 12:30 A.M. | 18 | 6:20 A.M. |
| 19 | 1:35 | 19 | 6:20 | 18 | 5:35 P.M. | 18 | 12:00 M. |
| 20 | 2:40 | 20 | 6:20 | 19 | 1:35 A.M. | 19 | 6:20 A.M. |
| 21 | 3:45 | 21 | 6:20 | 19 | 5:35 P.M. | 19 | 12:00 M. |
| 22 | 4:45 | 22 | 6:20 | 20 | 2:40 A.M. | 20 | 6:20 A.M. |
| 23 | No light. | 23 | No light. | 20 | 5:35 P.M. | 20 | 12:00 M. |
| 24 | No light. | 24 | No light. | 21 | 5:35 | 21 | 12:00 |
| 25 | No light. | 25 | No light. | 22 | 5:25 | 22 | 12:00 |
| 26 | 5:40 P.M. | 26 | 7:45 P.M. | 23 | 5:35 | 23 | 12:00 |
| 27 | 5:40 | 27 | 8:45 | 24 | 5:35 | 24 | 12:00 |
| 28 | 5:40 | 28 | 9:45 | 25 | 5:40 | 25 | 12:00 |
| 29 | 5:40 | 29 | 10:45 | 26 | 5:40 | 26 | 12:00 |
| 30 | 5:40 | 30 | 11:45 | 27 | 5:40 | 26 | 12:00 |
| 31 | 5:40 | 1 | 12:45 A.M. | 28 | 5:40 | 28 | 12:00 |
| | | | | 29 | 5:40 | 29 | 12:00 |
| | | | | 30 | 5:40 | 30 | 12:00 |
| | | | | 31 | 5:40 | 1 | 12:45 A.M. |
| | Total hours lighting, 218.40. | | | | Total hours lighting, 291.20. | | |

## Electrical Advances for the Half Year.

It is very instructive as the year is drawing to a close to look back over the months that have passed and examine the work that has been accomplished in the electrical arts and sciences. At the end of the last volume of THE ELECTRICAL WORLD we thus reviewed the progress of the first half of 1890, and it is now our pleasant duty to examine the inventions and researches that have signalized the past six months, and are recorded in our columns. On the whole this period has been more noteworthy from its advances in theory than from any striking innovations in applied electricity.

To begin at the beginning, at the very earliest of electrical arts, we find that telegraphy has gone quietly on in its wonted way without any striking inventions or unusual extensions. The spider web of lines that covers to-day the largest part of the civilized world has been stretching out, covering more and more of space, and linking widely separated parts of the world more closely together. Several short cables have been laid, and in fact more has been done in this department of telegraphy than in any other.

A very important paper has been published containing the results of some important experiments with galvanometers for cable use. This research was conducted by Mr. E. R. Barker, and treated of the advantages of the suspended coil type of galvanometer for operating submarine lines in place of the ordinary Thompson instrument, XVI., 357. The D'Arsonval valve type of instrument is coming into more extensive use than at any time previously and Mr. Barker shows that it is especially fitted for signaling over long submarine lines.

There is a strong tendency in telegraph offices to relegate the battery to the scrap heap and employ especially wound dynamos in its stead. The description of one large plant of this kind, XVI., 313, will serve as a type of the means adopted in introducing this modern improvement in telegraphy for this purpose. Motors are almost universally used to drive the telegraph dynamos, and the saving in expense secured is very large.

The telephone has had, like the telegraph, an uneventful history. The long-distance lines have been extended rapidly during the past summer, and that important part of telephonic service is in a better condition than ever before. At the Telephone Convention at Detroit early in September a number of interesting papers were presented, and among them we may especially mention Mr. Patterson's discussion of the housing and care of central office apparatus and Mr. Davidson's paper on the operation of the double cord key-board, XVI., 206; XVI., 201. These articles with the discussions upon them will give to the lay reader a vivid idea of the care required in conducting a telephone exchange and the cause of the little difficulties that are sometimes so exasperating, and that can only be avoided by the most extraordinary watchfulness.

Electric lighting has pursued its usual course of rapid growth. Plant after plant has been organized and put into operation. Some of the important ones elaborately illustrated in our columns have been that at Spokane Falls, Washington, notable as being a fine example of the application of water power to commercial lighting, XVI., 181; Woonsocket, R. I., XVI., 23, exhibiting another type of prime mover, the gas engine, doing excellent work in electric lighting; Jenkintown, Pa., XVI., 314; Uniontown, Pa., XVI., 185, and numerous others. Beside these the growth of isolated plants, which has been great during the past months, is well exemplified by the descriptions of the installations at the Progress Club, New York, XVI., 83; the Imperial Hotel, New York, XVI., 238; the Plaza Hotel, XVI., 331, and in a somewhat different department of electric lighting the elaborate plant on the new Sound steamer "Plymouth," XVI., 238. These illustrations of successful central stations and isolated installations give an excellent idea of the methods employed in the most successful modern practice, and cannot fail to be of service to those interested in the problem of commercial lighting.

The convention of the National Electric Light Association at Cape May was reported in full in our columns, XVI., 132, and its proceedings are worthy of special study, although we can here hardly do more than to call attention to their importance and the interest they excited. The convention report number of THE ELECTRICAL WORLD was the largest in the history of the paper, containing no less than 98 pages.

Of new electric lighting apparatus there has been much described since June. Dynamos, engines, switches, lightning arresters and line apparatus of every kind have been multiplied in the hands of inventors, as the most casual reference to our columns will show. One of the most striking of the new machines brought out is the remarkable Thomson alternator, XVI., 68, that has created so much discussion in foreign journals. Concerning the methods of electric lighting a number of valuable papers have appeared. Chief among them we may place the practical account of the uses of the alternating current as a distributor of electrical energy from central stations, contributed by Prof. J. A. Fleming to the London *Electrician*, to form a companion volume to his work on the alternating current transformer, and republished in America by THE ELECTRICAL WORLD only, XVI., 58, 73, 85, 104, 122, 157, 170, 303, 315, 335, 351 and 391, and still running. It is by all odds the most important addition to the literature of alternating current as regards its practical employment that has ever been written.

Still other important papers have been that by M. Reckniewski, dealing with some interesting problems of dynamo design; Mr. Perret's article on multipolar machines, XVI, 393; the important contribution of Herzog and Stark to the subject of electrical distribution, XVI., 128, enunciating some important propositions of great practical importance in spite of their mathematical surroundings. This is but an incomplete list.

The electrical transmission of power has been steadily growing through the entire year. Its most important development, the electric railway, has been peculiarly rapid in its advances. Two new street railway systems have been placed before the public; one of them, the Westinghouse, is already in extensive use. The exploitation of this excellent system was carried on so quietly that many roads were on contracts before the details of the apparatus were made public. The first publication of the Westinghouse electric railway was the illustration in THE ELECTRICAL WORLD of the first road operated on that system in Lansing, Mich., together with some facts about the apparatus employed. This was published within a short time after the opening of the road, XVI., 197, and up to the time of the street railway convention was the only authoritative description of the Westinghouse railway. At that time a further description, XVI., 277, was given. In the same number of THE ELECTRICAL WORLD was published a full account of the earliest electric railway operated, now nearly half a century ago, XVI., 276. Still another electric railway system, the Wenstrom, has been brought before the public during the summer, and is possessed of some very remarkable features in its low armature speed and unique hydraulic gearing for attaching the armature to the axle. So interesting were the peculiarities of this system that considerable space in our columns was devoted to an elaborate description of it, XVI., 294. The Short electric railway system, too, has been pushed vigorously, and, at present writing, its great installation at Rochester, N. Y., is nearly completed, and cars are already running. A full description of the colossal power station there is to be found in THE ELECTRICAL WORLD, XVI., 444. Other railway power stations now in active operation and recently described are that at Albany, XVI., 164; full details of the plants for the great West End power station in Boston, XVI., 281, and the power station in Newark, XVI., 417.

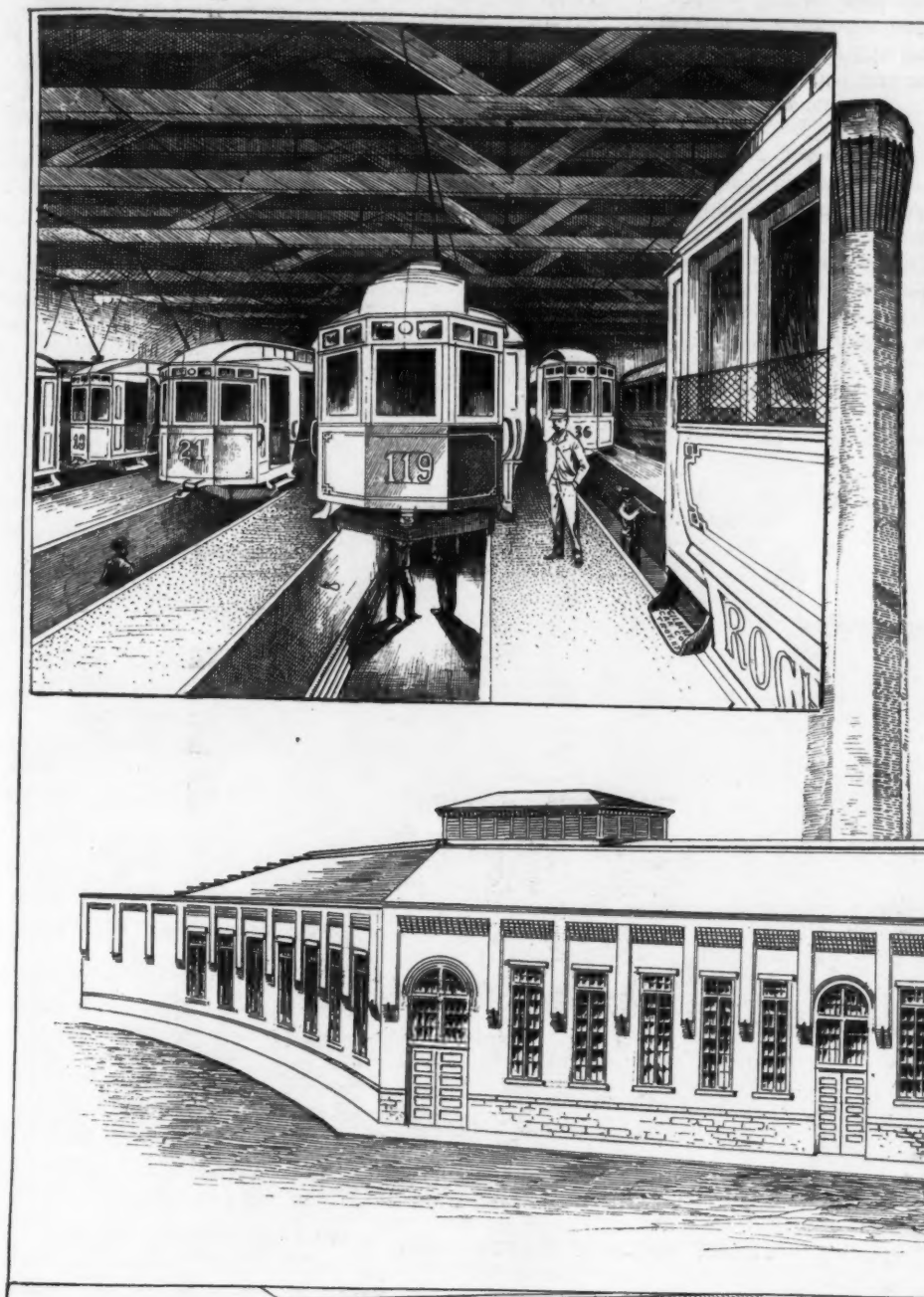
The National Street Railway Convention at Buffalo, in October last, was reported in full in THE ELECTRICAL WORLD, and for the number which was distributed at that important gathering a special effort was made to obtain practical details of the operation of many electric roads. A circular letter was sent out from our office to all the electric railways in the United States, asking a long list of carefully arranged and searching questions regarding the practical running of electric roads, cost of power, cost of repairs, the increase in traffic resulting from the use of electricity, the performance of cars, grades, the life of various parts of the apparatus, and other questions of no less importance. Through the kindness of our many street railway friends a very full set of replies was obtained from these inquiries; and from them a general abstract of results was compiled. We venture to think that this contains many facts regarding electric traction which had never before been published, and much information that it would be impossible for the public to obtain through any other means than that taken. Among the interesting facts brought out was the average cost of power, which, from the average of nearly a hundred roads, appears to be almost exactly two cents per mile; the average daily mileage of each car being just over a hundred miles. From a somewhat smaller number of replies an average of the cost of repairs was made out, and from this it appears that this item of expense is a little less than one-fifth the total operating expenses, although in later roads the marked improvements is signalized by the reduction of repair expenses to a figure much below that just mentioned.

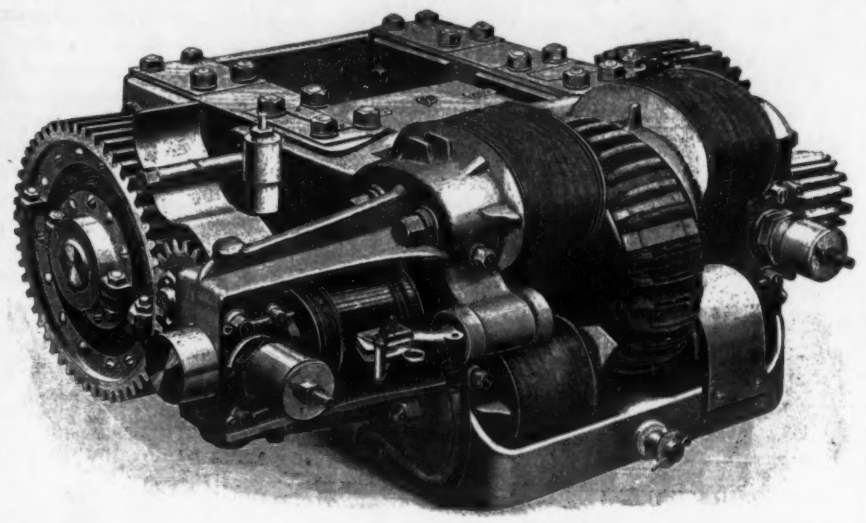
In a similar line of electric work is the application of electricity to mining. For tramways in mines electric power seems especially well adapted, and a most interesting historical résumé of the growth of this department of electric traction in one important coal field may be found in our columns, XVI., 198. The use of the electric motor for operating mining drills and similar apparatus has been excellently illustrated in the large installation at the Willock Mine, remarkable for being equipped with alternating motors, XVI., 115.

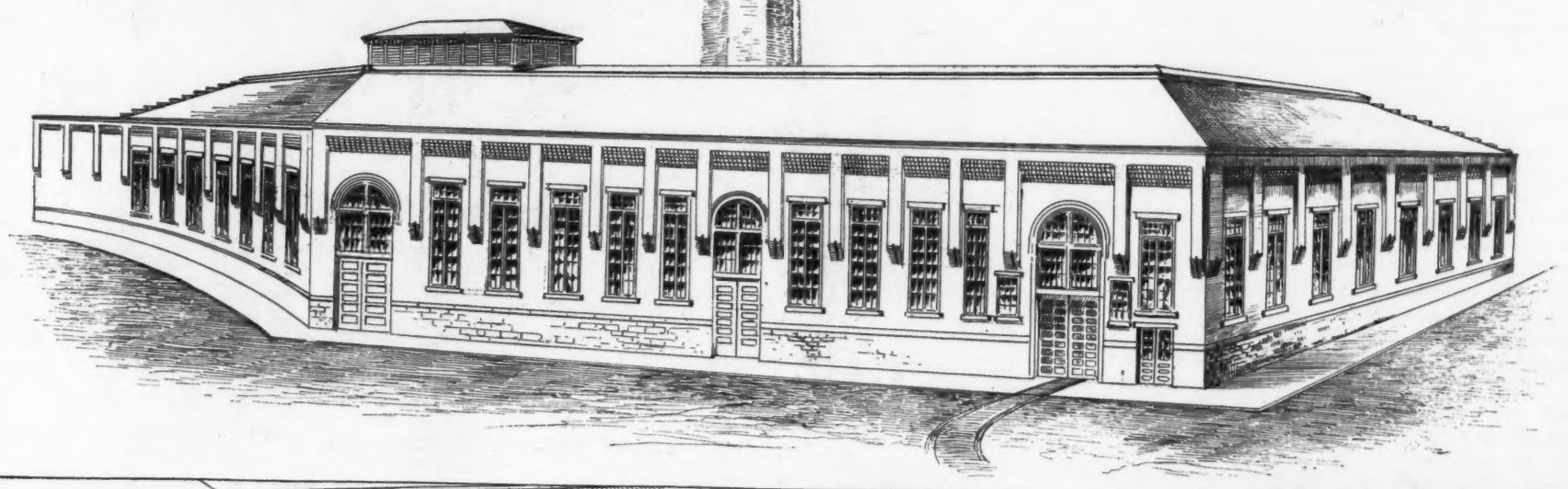
In the storage battery field it is worth noticing that an important Patent Office decision, XVI., 87, leaves the field clearer for the application of the storage battery to traction than it has been before; while two splendid papers by Prof. Ayrton and his associates on the working efficiency of secondary cells put the chemical action which takes place in the accumulator in a clearer light than it has ever been before, XVI., 89, 107, 124, 159.

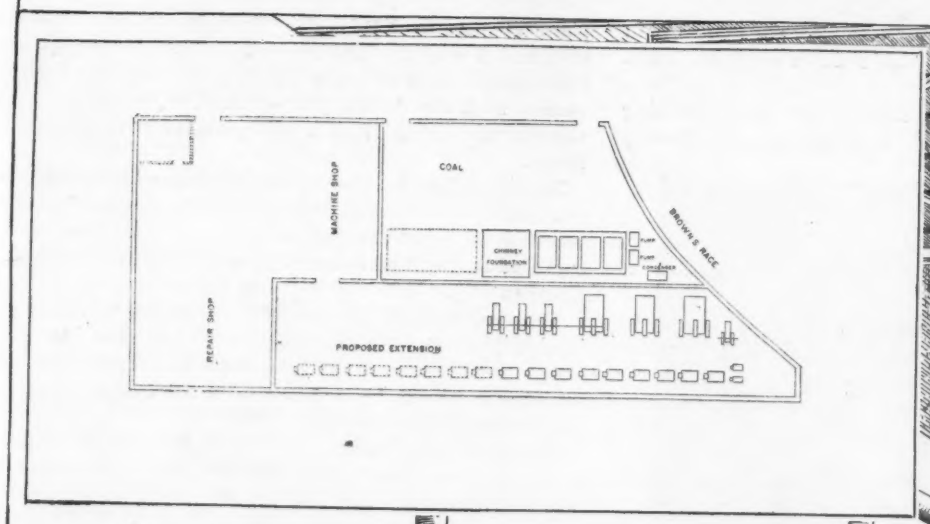
The most remarkable single paper that has appeared in the past six months is probably that by Prof. J. A. Ewing on "The Molecular Theory of Induced Magnetism," read before the British Association in September last, XVI., 241, 262. In this research Prof. Ewing has done more to explain the actual mechanism of magnetization than any investigator in magnetic theory since Maxwell. The conception of a magnet as built up of a heterogeneous mass of magnetic molecules lying in comparatively stable groups until the magnetizing force is applied makes the complicated phenomena observed clearer than most scientific men have ever ventured to hope. The research is really an epoch-making one and deserves the most elaborate study. In connection with this should be mentioned the brilliant Cantor Lectures by Prof. S. P. Thompson. These have been running through the latter portion of the present volume, being published with the author's own revision, simultaneously with their appearance in England. Starting from the idea of the magnetic circuit Prof. Thompson has succeeded in putting the design of an electromagnet for general use in a simpler form than has ever before been attempted. He has really succeeded in doing for the electromagnet in general what Dr. Hopkinson did for the dynamo; and the series of lectures now just completed, and about to be issued in book form, constitute a contribution to electrical literature that can hardly be over-estimated. The most recent theories of electricity, dealing as they do with the remarkable advances of the past two years, especially in the direction of electromagnetic radiation, have been the subject of much research. A brilliant paper by Prof. Hertz, formulating his latest discoveries in convenient shape for general reference, has been translated in our columns, XVI., 210, 223, 285, 302, 334, 350; to it those of our readers who are interested in the developments of mathematical electricity may be well referred. For those who desire a more popular account of the most recent ideas in electricity nothing could be better suited than the clever discussion by Prof. Kimball of the latest views as expounded by Lodge, Hertz, and others, XVI., 332, 348.

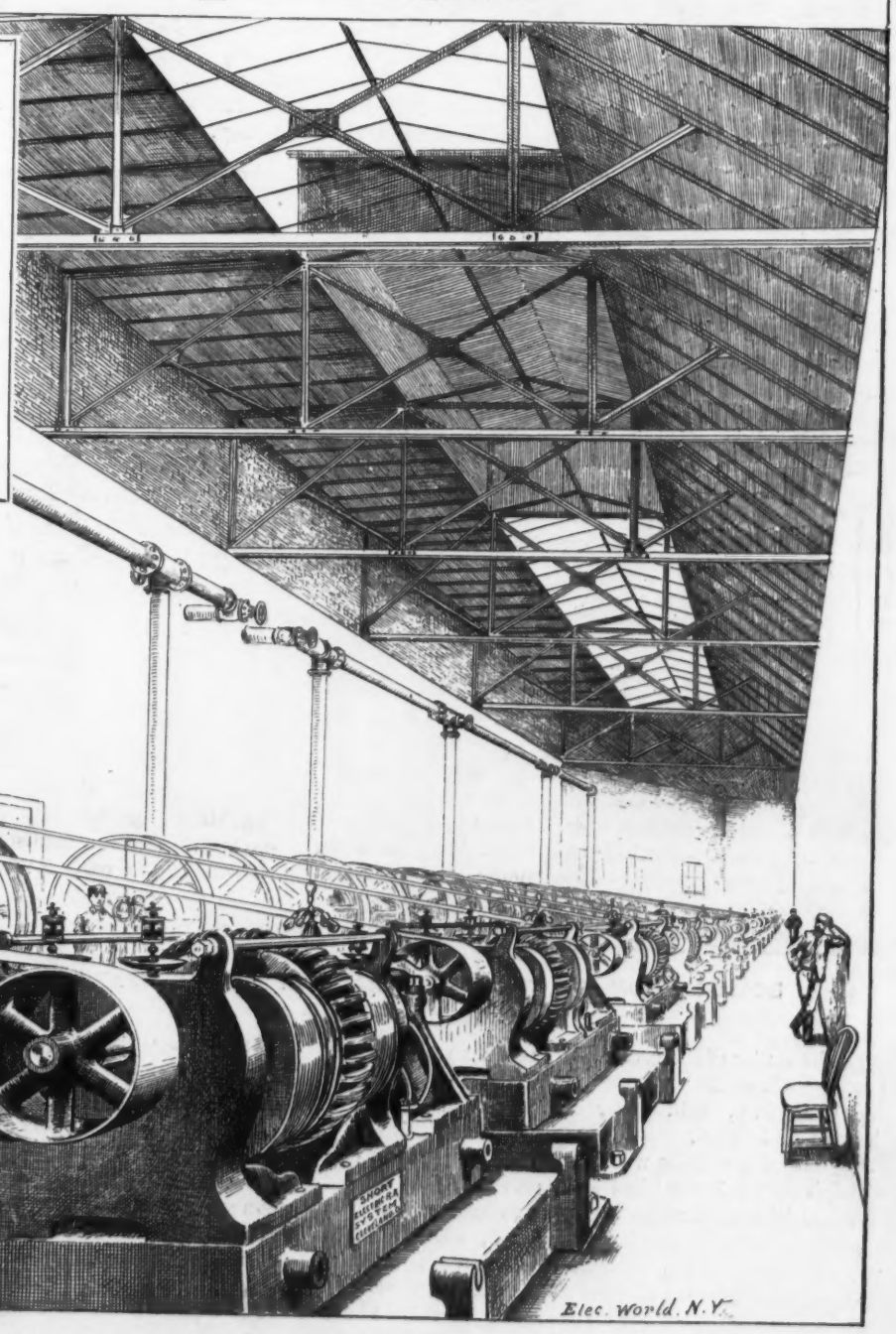
The meeting of the British Association for the Advancement of Science produced, beside Prof. Ewing's remarkable research, a number of striking papers on various topics, prominent among them being two by Sir William Thomson on "The Conduction of Alternating Currents," taking into account the various phenomena that complicate the action, XVI., 224, 225. Another interesting discussion was "The Theory of Submarine Cables for Telephonic Purposes," presented by Mr. W. H. Preece, whose long experience has made him a commanding authority such subjects.








THE SHORT STREET RAILWAY POWER STATION AT ROCHESTER, N. Y.

Finally, we may mention as one of the most interesting discussions of theory in its connection with practical problems Prof. E. L. Nichols' lecture upon "The Artificial Light of the Future," in which he deals with the imperfections of the present methods of producing illuminations, and discusses the directions in which we may hope to look for improvement. A considerable additional number of theoretical papers have appeared in our columns during the period covered by this brief review, but we simply call attention to some of those which are of a commanding importance.

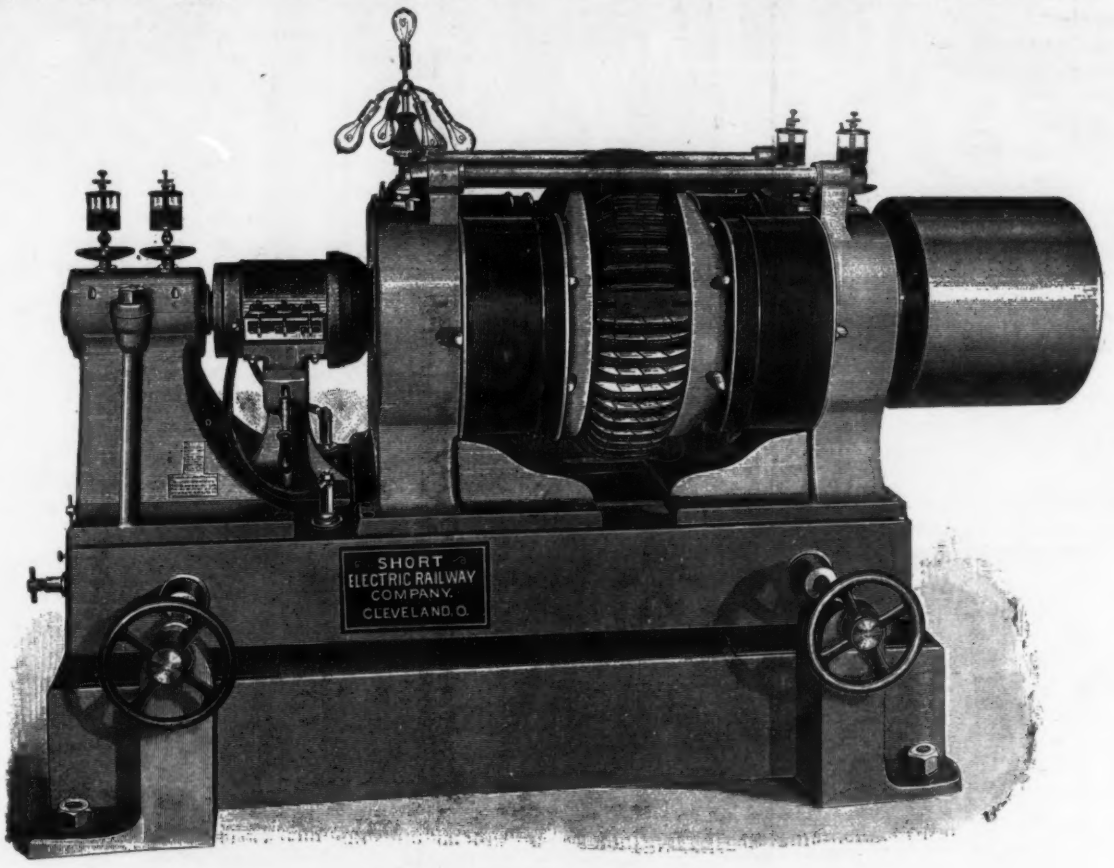
In closing it is fitting to mention that several new features have been added to THE ELECTRICAL WORLD during the current volume, chief among them being a weekly cable despatch from London giving the latest English and Continental news; and a weekly discussion of the electrical stock market. These cannot fail to be acceptable additions to the contents of the paper, and to make it more completely than ever what its name would indicate, a cosmopolitan journal of electricity.

### The Short Electric Railway System at Rochester, N. Y.

In the last number of THE ELECTRICAL WORLD an illustration was given of one of the splendid vestibuled cars with which a large part of the street railways of Rochester is now being equipped, to be operated by electricity. This system will, when completed, be one of the largest and most important in the country, and those who have already become interested in the progress of the work upon the Rochester power plant will be able to obtain from the accompanying illustrations additional details of the preparation now being made for the immediate operation of 100 of these vestibuled cars from a single power station.

On the preceding page is shown an illustration of the exterior of the power station now practically completed together with a plan view of the ground floor as it will ultimately be arranged. The power station is a model one in every respect, many new and unusual arrangements to facilitate work being incorporated in the plans. The floor of the car house is supported upon pillars, and instead of ordinary excavations in which men inspect the motors hung beneath the cars, there is in the new building a large basement carefully arranged, lined with masonry and ceiled with cement. The cars are on the tracks overhead within easy reach, and the entire room is thoroughly dry, well lighted and well ventilated. This arrangement provides for the rapid handling and examination of cars when in service. The repair shop, the location of which is shown in the plan view of the station, will be equipped with all the machinery and tools necessary for the ordinary repairs of both cars and car motors.

In the dynamo and engine room it will be seen that the generators and engines are placed in two regular rows




SHORT RAILWAY GENERATOR.

BOILER ROOM OF THE SHORT RAILWAY POWER STATION AT ROCHESTER.

through the centre of the room. The engines used are the Ball compounds of 300 h. p. each, and single cylinder Ball engines of 150 h. p. each. Four of the former and 10 of the latter will be used.

The dynamos are of the well-known Short pattern, one of which is shown in the illustration on this page. One of the distinguishing characteristics of the Short generator is a ring form of armature of large diameter, which admits of slow speed in running. The large diameter of the armature makes it possible to wind each bobbin in a slot by itself. The pole pieces of the magnets are presented at the side of the armature instead of at its rim, and the field magnets are compound wound, insuring the perfect regulation of the generator. Carbon brushes are used, and the commutator is of large diameter. No shifting of brushes is necessary under variations in load. These generators are made in all sizes from 50 to 500 h. p. capacity. The larger machines have eight field magnets, and are very slow in speed. They are arranged to run with belts in the ordinary way, or to be connected with the engines without the use of belts or pulleys of any kind.

The view of the dynamo room, given in our page of illustrations, gives an idea of the appearance of the long row of Short generators which will be required to operate the proposed system.

One hundred cars are now ordered and are being equipped with Short motors, two of 15 h. p. each being placed upon each truck. One of these motors is shown at the top of the preceding page. Insulation is provided between the motor frame and the ground by wooden webs in all gears. This arrangement also reduces the noise made by the gears.

The cars were made by the Gilbert Car Manufacturing Company, of Troy, N. Y., and each has an 18-foot body and is vestibuled at both ends, as shown in our illustration last week. Bemis and Peckham trucks are used, the Bemis having a seven-foot wheel base and the Peckham six feet and six inches. The line is 18 feet from the surface of the street. No. 0 wire is used in the city and No. 1 in the suburbs. The size used for feed wires depends upon the circumstances and varies from No. 00 to No. 0000, as the case requires. The size is so calculated that the potential over the whole city will be as nearly as possible a constant.

The boiler room, as shown in this page, contains at present four Heine boilers of 200 h. p. each. The chimney is 165 feet in height, and is eight-cornered on the outside. The flue is cylindrical and has a uniform diameter of nine feet. The air spaces between the outside shell and the flue extend 50 feet from the boiler room floor. Mr. R. L. Caldwell has had charge of the line work, and Mr. J. C. Lincoln is the electrician. The officers of the company are: A. G. Yates, president; John N. Beckley, vice-president and secretary; Arthur Luetchford, treasurer; M. A. Verner, manager for syndicate; Norman M. Crawford, local general manager.

### A Compact Lighting Plant at Allegheny City, Pa.

There is, perhaps, no other electric lighting plant in this country where an equal number of lights are operated from such a small central station building as is done in the plant at Allegheny City, Pa. The plant is owned by the city, and it operates the alternating system exclusively, both incandescent and arc lights, and it is partly for this reason that the company is enabled to run such a large number of lights from a comparatively small power house.

The plant has a capacity of 4,500 incandescent and 540 arc lights. It was established last spring, and the contract for the installation of the electric light system was awarded to the Westinghouse Electric and Manufacturing Company.

The power house is a very handsome brick building, situated near Braddock street and the tracks of the Pittsburgh, Fort Wayne & Chicago Railroad. The roof of the building is graced by a beautiful tower, from which the main wires are distributed.

The boiler room is in the rear of the building, containing a battery of six tubular boilers, each measuring 16 feet in length with a diameter of 65 inches. Slack coal is utilized as the fuel under the boilers, and each of the latter is also fitted with a Roney patent stoker. The utility of this appliance has manifested itself in this plant to a very great extent from an economic point of view.

From the boiler room, a small door leads into the power house proper, the dimensions of which are 30×56 feet, and in this space all of the engines and dynamos for the operation of the complete plant are confined as follows: There are eight Westinghouse compound engines, two automatic engines, three 1,500-light alternating current incandescent dynamos, two exciters, and nine 60-light alternating current arc machines.

The switchboard of both the incandescent and arc light circuits occupies the greater portion of the north wall in this room, containing all the switchboard appliances used in connection with the Westinghouse system of electric lighting.

The plant has been in operation since the 15th day of July last, and, since that time, there has never been any interruption in the service, either in the incandescent or arc light supply. The working of the central station is superintended by Mr. David Hunter, Jr., and Maurice Coster acts as chief engineer. The arc lights are used to light up the streets of the city. All the construction work on this plant was done by the North American Construction Company. The lights are distributed by mast arms and towers. Of the latter, the city has put up 53, with five lights on each, and the rest of the lights are on mast arms. The lights have given satisfaction to the people of Allegheny City, and the effect of the illumination from the towers is said to be very brilliant. Since the plant has been in operation the city has realized that the present capacity of the station is hardly sufficient to meet the demands of the entire place, and an extension is already contemplated.

## Electrical Distribution by Transformers from Central and Eccentric Stations.*

BY DR. J. A. FLEMING, M. A.

### THE THOMSON-HOUSTON TRANSFORMER SYSTEM.

§ 1. In the United States one of the most widely known of all the electric lighting companies is the Thomson-Houston, having its headquarters in Boston, Mass. Commencing in 1880, and having in 1882 only a small factory at New Britain, Conn., this corporation has developed its electrical manufactures at a steadily increasing rate, and has at the present time an immense factory at Lynn, Mass., occupied in the production of electric lighting plant for arc and incandescent lamps, as well as for electric locomotion. In the United States over 50,000 arc lamps are operated by the well-known Thomson-Houston continuous current arc light dynamo, in some 600 or more stations. The ingenuity and remarkable inventive skill of Prof. Elihu Thomson has also been brought to bear on the development of an alternating transformer system, with the result that nearly 100,000 incandescent lamps are in use (1890) in the United States in connection with a transformer system as devised by him. The alternating dynamo employed in the Thomson-Houston transformer system presents some interesting peculiarities.

Fig. 1 shows the general form of all the dynamos for generating alternating currents manufactured by the Thomson-Houston Electric Company. The field magnets are of cast iron, and are made in two parts, the lower one bearing the pedestals for the armature bearings. Each casting carries projecting inward from it one-half the total number of radial pole pieces. The number of polar projections varies from eight in some of the smaller sizes to 22 in the largest. The armature is a laminated iron cylinder, and has applied to its surface a set of flat coils which form one layer of double insulated copper wire of square cross-section. This armature winding, then, consists of a number of flat oval coils, equal in number to the number of polar projections, wound in a lathe on special formers. There is a space of three-quarters of an inch or more in the centre of each coil which, in some machines, is filled with insulating slip or core, and in others with a second separate coil used for exciting the field of the dynamo. The armature coils are securely bound to the armature core by brass wire, and are covered with insulating strips of mica. These coils are either connected all in series and in series with the external circuit as is shown in Fig. 2, in the case of smaller sizes of high potentia machines, or they are wound as shown in Fig. 3; *i. e.*, two groups in multiple, consisting of an equal number of coils in series. By this means a 1,300 light armature is wound with wire of the same size as a 650 lighter.

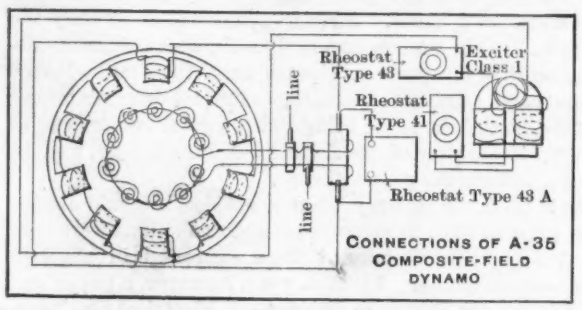



FIG. 2.—CONNECTIONS IN THOMSON-HOUSTON ALTERNATOR.

The armature core, in these machines, is built up as usual of thin iron sheets perforated with apertures through the centre, so as to allow a circulation of air.

These alternating current dynamos are made in three types, as follows :

(I.) Self excited.
(II.) Separately excited.
(III.) Composite wound.

(I.) *Self-Excited Type.*—In this class of dynamo, which has been now more or less discarded in favor of the third mentioned, the field-exciting coils are wound about the armature in a manner like the ordinary Siemens winding, and consist of but a very few turns of square copper wire. These coils are arranged as shown in Fig. 4, and they lie beneath the main armature coils and fill the spaces on the surface of the iron core between the wires of the flat or " pancake" coils, as they are sometimes called. The upper sketch in Fig. 4 shows the manner in which these coils are wound over the ends of the core, the two opposite coils being either connected in series or in multiple arc and their terminals brought out to a commutator on the shaft outside of the bearings at the collector end of the dynamo. This commutator has as many segments as there are poles on the dynamo, and the two terminals of the field-exciting circuits on the armature are connected to alternate segments. The exciting current is controlled by a rheostat in its circuit mounted upon the switchboard, and in this circuit are included the coils on the field magnets. This design may, in fact, be described as an alternate current armature winding on the top of a continuous current winding. This last supplies current for the field.

* Continued from THE ELECTRICAL WORLD, Dec. 6, 1890.

(II.) *Separately Excited Type.*—The separately excited dynamo is of the same form as the self-excited, the only difference being that in it the commutator and armature exciting coils are absent. It is used with an exciting dynamo, such as shown in Fig. 1.

(III.) *Composite-Wound Type.*—The term "composite" as applied to the third type of the alternating current dynamo of the Thomson-Houston Electric Company was adopted to distinguish this arrangement of field excitation from that employed in direct current machines, which consists in the combination for producing the magnetic field of the main armature current with a derived current shunted around the external circuit. The arrangement of circuits which is used on the most improved type of

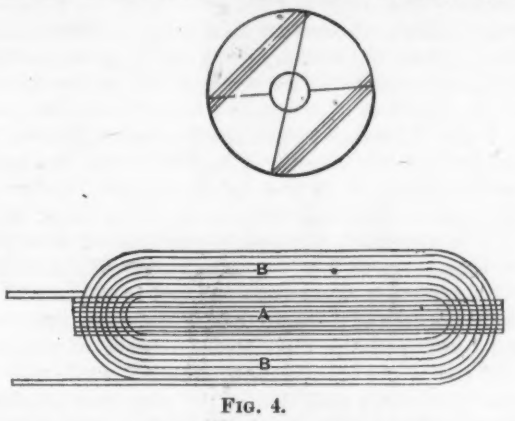



FIG. 4.

Thomson-Houston alternator for maintaining a constant difference of potential at a defined point of distribution, regardless of load, is shown in Figs. 2 and 3.

A part of the magnetic field is maintained by means of current from a separator or exciting dynamo. If the load upon the outside circuit is increased it is necessary to increase the magnetism of the field in order that the machine may in turn supply the increased demand in the circuit and the lights remain steady.

This is accomplished in other machines by varying the current on the field magnets by a rheostat or variable resistance operated by hand. In the Thomson-Houston dynamo, however, the same result is obtained entirely automatically by passing the greater portion of the main current through two or more of the field magnets, thus energizing the machine in exact accordance with the demands made upon it. As an alternating current is not suitable for magnetizing the fields, it is necessary to change the character of the current produced in the armature to a direct current before passing it through the special winding on the field, and this is done by a commutator at the end of the shaft. By this regulation the attention required at the dynamo is reduced to a minimum, while at the same time the efficiency of the machine is increased, and any number of lamps, from one to the full capacity, may be thrown on or off without in any way affecting the steadiness and brilliancy of those remaining.

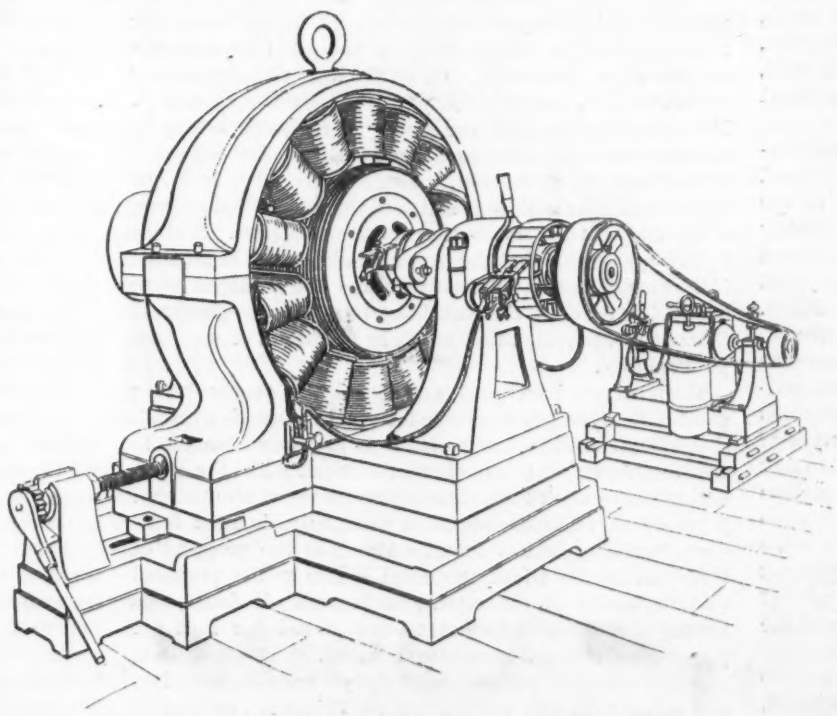


FIG. 1.—THOMSON-HOUSTON ALTERNATOR.

To allow for a pre-determined percentage of loss in the wiring, it is necessary, as the load is increased, that there should be a definite amount of increase in potential, which is accomplished by placing around the field winding for the main current a resistance which shunts that portion of current not required for regulation.

It is precisely the same in principle as the compound winding in the case of a continuous current machine. In addition to the current derived from a small direct current separate exciter, a second current, which is a rectified portion of the main current, is used to energize the fields. This current, being proportional to that in the external primary circuit increases the field strength, and thus the potential with increasing load.

It will be seen from the diagrams of the connections that the armature current is "rectified" for a part of its course by means of a commutator having as many segments as there are field poles on the machine—alternate segments being connected together, and one set connected to one armature terminal, and the other to the external circuit.

This rectified current is either used to excite two of the polar projections, as in Fig. 3, or to partially excite all of them, as in Fig. 2, the latter method being the most approved.

Before each machine is sent out from the factory, the strength of the compounding current is regulated by means of a German-silver shunt fastened to the frame of the machine. By changing this shunt the machines may be made self-regulating for any required line resistance or drop, being over-compounded to whatever degree is needed. The winding may be described as that of a "compounded" alternator for giving constant potential at the ends of a line.

The following table gives the sizes and capacities of the machines of this type thus far constructed, with the exciting and main current of each:

| Alternator. | Watts. | Lamp load in 16-c. p. lamps. | Exciting circuit. | | Weight. | Speed. | Floor space, (ins.) | Output in amps. |
|---|---|---|---|---|---|---|---|---|
| | | | Volts. | Amp. | | | | |
| A 35 | 35,000 | 650 | 100 | 5.8 | 3,570 | 1,500 | 66×45 | 35 |
| A 70 | 70,000 | 1,300 | 100 | 11.2 | 8,270 | 1,076 | 84×56.5 | 70 |
| A 140 | 140,000 | 2,600 | ... | .... | .... | 620 | 80×105 | 140 |

Each machine yields current at 1,000 or 2,000 volts as required.

For the purpose of energizing the field magnets the dynamos are furnished with small exciting dynamos of the

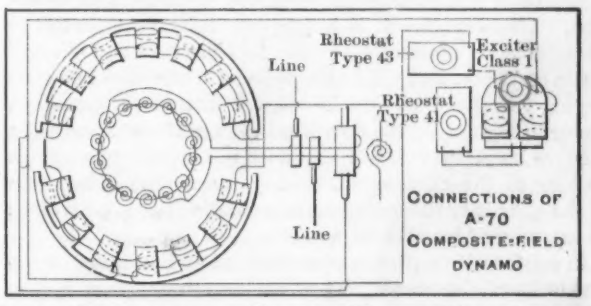



FIG. 3.—CONNECTIONS IN THOMSON-HOUSTON ALTERNATOR.

direct-current type. It has been found desirable in some special cases to make the smaller sizes of alternating current dynamos self-exciting, and to this end the armatures are wound with an extra or special coil for furnishing current to energize the fields.

The exciter is usally placed, as shown in Fig. 1, behind the alternating dynamo, driven by a belt from a small pulley attached to the armature shaft. One exciter is usually employed with each alternating current dynamo, but when several dynamos are operated in the same station it is often found more convenient to employ exciters, any one of which is of sufficient capacity for all the machines. By this arrangement an accident to one exciter need not affect the general service.

Exciting dynamos are made in the following sizes:

| Class. | Volts. | Ampères. | Speed. | Weight. | Pulley diam. | Pulley face. |
|---|---|---|---|---|---|---|
| 0 | 100 | 12 | 2,300 | 307 | 4 | 2 |
| 1 | 100 | 24 | 2,200 | 480 | 5 | 3 |
| 2 | 100 | 40 | 1,800 | 696 | 6 | 4 |
| 3 | 100 | 60 | 1,600 | 1,080 | 8 | 5 |
| 4 | 100 | 80 | 1,600 | 1,364 | 8 | 6 |

The current required in the fields of the alternating current dynamo is as follows:

A-35 composite field, 5.8 ampères.
A-70 composite field, 11.2 ampères.

*(To be continued.)*

### Lighting and Traction in Italy.

A peculiar installation for lighting and traction was opened a few weeks ago, says the London *Electrical Engineer*, between Pazzala and Lugano, in Italy. A waterfall supplies the water conducted through iron pipes to the generating station, where two Girard turbines of 300 h. p. each drive two dynamos, one for continuous and the other for alternating current, the former working the tramway motor, the latter supplying 1,500 glow lamps of 16 c. p. each at the hotel, the tramway line, and at private buildings The double track is one mile in length, and is worked by a cable 1.3 inches in diameter, supported by wooden rollers, one branch of the cable attached to the ascending, and the other to the descending car, each of them weighing 4¼ tons. The generating dynamo gives 60 h. p. at 1,800 volts, and 22 ampères for 700 revolutions per minute. The electric motor for the cable produces 40 h. p. at 700 revolutions, so that the efficiency of transmission will be 66 per cent., the conductor being an overhead wire 0.2 inch diameter, carried on oil insulators. A spare steam plant of 50 h. p. is provided in case of failure of water supply.

## Inductance and Its Proposed Unit, the Henry.*

BY A. E. KENNELLY.

Perhaps the greatest discovery of Faraday's long career of scientific research was that of electromagnetic induction in the year 1831, when he first brought to light the influence exerted by a magnet or a current upon surrounding matter when subjected to a change of magnetic potential. Oersted had shown that a conductor carrying a current exercised electromagnetic influence at a distance, and Ampère had enunciated those simple and beautiful laws this influence is admitted to obey, but Faraday's discovery was a great step; it revealed the action of magnetic force in apparently empty space; it inaugurated that deeper insight into the mechanism, still only dimly guessed, which connects matter with all other matter in space; and it invested the all-pervading ether with a dignity and power that in the hands of many great men since his time has probably paved the way for our future comprehension of magnetism, gravitation and radiant energy, while making the hypothesis of action at a distance a mere mathematical conception and process of thought.

The development of this discovery of electromagnetic induction has practically created electrical engineering. for it is to machinery operating by electromagnetic induction that we owe nearly every branch of electrical industry except, perhaps, telegraphy, the forerunner of all; and the condition of modern electrical engineering is such that the units and nomenclature relating to steady currents and permanent magnets is insufficient for practical requirements, and the conditions developed by variable currents and magnets demand the establishment of engineering practical units for the purposes of convenience in expression and computation.

Foremost among those required units is that of inductance, or as it is commonly called the coefficient of induction. This inductance is a property fully as essential to every electric conducting circuit as resistance and electrostatic capacity, and the inductance of a circuit when conveying variable currents is often a far more important factor in regulating the flow than the ohmic resistance. In fact we know that Ohm's law does not apply to a circuit so long as the current is unsteady, unless the inductance of the circuit or the counter electromotive force it involves be introduced into the expression.

In conformity with the conventional and so-called absolute units of electromagnetism, an inductance is a length and theoretically can always be computed from the geometrical relations of a circuit; that is to say, if the distance of each point from all other points of a circuit be measured, or inferred, in inches or centimetres, the inductance of the circuit will be some definite number of inches or centimetres, capable of being determined by a possible if not a convenient process of summation. If the circuit, however, be associated with iron or other magnetizable matter, then the magnetic permeability of the environment will enter the terms of summation as a multiplier. In the absolute centimetre-gramme-second system of units, inductance will be necessarily expressed in centimetres, and the centimetre is thus the natural scientific unit, although unsuited to the requirements of electrical engineering.

It may be well to notice that inductance is only conventionally and perhaps not essentially a length. Prof. Rücker has pointed out,† that the multiplication of the permeability factor with the length factor is always tacitly if not expressly involved, even when the circuit considered is far from magnetizable matter in the ordinary sense; that is to say, when residing in a medium of unit permeability, and therefore the nature of inductance is not merely length, but length multiplied by permeability, while physics has not yet decided whether permeability is the simple numerical factor at present assumed, or a function of length, mass and time. Until this question is settled, the real nature of inductance must be considered as doubtful, and the fact that inductance will probably, in any event, be always measured by lengths is no more validly an argument as to its nature than the usual determination of a body's mass by the earth's gravitational force upon it is an argument that mass is a force. However, the question is one of theory only, and does not affect the consideration of the practical unit.

As has been pointed out by Dr. Sumpner,‡ there are no less than three ways of defining the inductance of a circuit, or a portion of a circuit, and three definitions are equivalent when the permeability of the magnetic medium is unity, but are not generally equivalent in the opposite event, being then only related in a definite manner by the magnetic properties of the medium. In other words, the inductance of a hollow solenoid of copper wire, placed in a vacuum and far from all iron, has the same numerical value in each of the three definitions, but if an iron core be inserted in it, its inductance will depend upon the definition selected, and will only be capable of interpretation from its value in one to its values in the others, by taking into account the characteristic permeability curve of the iron, and the conditions of the measurement.

For convenience and general use, however, the secondary definition of Sumpner and Fleming§ is probably the best to adopt, and valuations in the other two can be reduced if necessary to this when the data for so doing are available.

The inductance of a circuit or portion of a circuit is then the ratio betwen the total induction through it to the current producing it. Thus taking a simple helix of five turns carrying a current of two units, and assuming that 1,000 lines of force,* passed through the central turn, of which owing to leakage, only 900 thread the next adjacent on each side, and again only 800 through the end turns, there would be 800 + 900 + 1,000 + 900 + 800 or 4,400 linkages of lines with the wire, and this being with two units of current there would be 2,200 linkages with unit current, and consequently the self-inductance of the helix would be 2,200 centimetres. (Fig. 1)

The fact that such helices are used in galvanometers, and that the magnetic force at any point within them is admitted to be proportional to the strength of the traversing current, renders it evident that had the current in this case been one unit, 2,200 lines linked with the coil would actually have been produced. Supposing, however, that the helix had been wound upon an iron core, the total number of linkages with the same two units of current would have been greatly increased, perhaps twenty-fold or to 88,000, and the inductance then by the same rule would be 44,000. In this case one unit of current would not in all probability reduce the number of linkages to 44,000; the exact number would depend upon the characteristic curve of the iron core and the degree of saturation, so that it would now be necessary to state the conditions of the measurements along with the result, in order to convey a clear and definite meaning.

It appears anomalous at first sight to state the above inductances in centimetres when they are derived from the number of lines of force, but it is to be remembered that the total number of linkages is divided in each case not by a mere numeric, but by a current, and this quotient can be proved to be a length in the existing system of dimensions.

In the same way the mutual inductance of two conductors is the ratio of the total induction through one of them to the strength of current in the other producing it. Suppose two coils of copper wire to be held in free space far from iron, and let one of them be traversed by a steady current of say four units. Of all the lines of force issuing from this coil, suppose 500 pass through the other coil. For simplicity, imagine the second or recipient coil to be composed of eight turns so disposed that the 500 lines pass through all in succession. There will then be 4,000 linkages of lines with that coil, and the mutual inductance of the two will be 4,000 ÷ 4, or 1,000 centimetres. It is interesting to notice that the same result would be reached if the second coil had the current and the linkages were counted in the first, the pair being mutually conjugate in this respect, provided they reside in a medium of constant permeability.

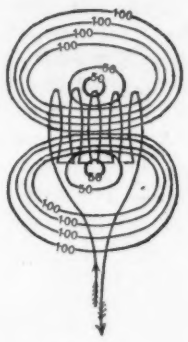



Fig. 1.

Thus far we have only considered the centimetre or absolute unit, whose unfitness for practical use is evident, since the smallest inductance that is at present known to engineering amounts to several thousand, while the average values met with are counted in millions of centimetres. It would of course be possible to name suitable units from the metrical system of lengths, but it is the proposal of this institute to adopt the word Henry as the practical unit, in honor of the man, who beyond all doubt, was among the foremost to extend the knowledge thus far possessed of self and mutual inductance.

If the selection of the practical unit were entirely free and subservient only to practical requirements, so that its magnitude should express ordinary values in digits with fewest decimals on the one hand, or large numbers on the other, there seems most reason to believe that the thousandth of the earth quadrant or myriametre would be the most eligible.

| Proposed name. | Length. | Number of centimetres. | Unit. |
|---|---|---|---|
| Henry. | Earth quadrant | 1,000,000,000 | Practical unit. |
| | | 100,000,000 | |
| | | 10,000,000 | |
| Millihenry. | Myriametre. | 1,000,000 | |
| | Kilometre. | 100,000 | |
| | Hectometre. | 10,000 | |
| Microhenry. | Decametre. | 1,000 | |
| | Metre. | 100 | |
| | Decimetre. | 10 | |
| | Centimetre. | 1* | Absolute unit. |

* The term line of force here is used in the sense of a line of induction; the distinction being necessary when the lines pass through iron.

Of course large iron machines employing many turns of wire linked by dense magnetic fields would have inductances more appropriately expressed in earth quadrants, which might then be termed the kilohenry just as we now have the watt and kilowat, but there is one restriction which makes such a selection undesirable, and that is the hitherto unbroken system of practical units itself. This practical system is a sub-scheme of the great international C. G. S. system and especially planned for adaptability to practical requirements. It is derived from that parent system by the substitution for the unit of length, one thousand million centimetres in place of one centimetre, and for the unit of mass an impalpable entity definite only in thought, the one-hundred-millionth of a milligram in place of the gram. By this substitution in the C. G. S. electromagnetic units, we obtain the hitherto unbroken system of the volt, ohm, ampère, coulomb, joule, watt, and farad. Even these units are not always the most convenient; witness for example the microfarad in common use, whose prefix is maintained simply in deference to the harmony of the system, for the farad is a capacity that exists only in imagination, the capacity of the earth itself being only about 700 microfarads, and of the sun, or rather a sphere having the apparent dimensions of the sun, being only about 76,000 microfarads. On the other hand, a proposition has lately been made to infringe the system by making the volt, the ampère and the watt ten times their present values, on the ground of practical convenience.* However, at the present time it would surely be unadvisable to attempt the precedent of infringing a system that has hitherto been supported by time, custom and international Congress.

In this practical system, the unit of inductance must be 1,000 million centimetres. That is an earth quadrant, or the distance from the pole to the equator, measured on the meridian of Paris. Strictly speaking, it is only the quadrant of the French standard earth, which is about one-hundredth of one per cent. shorter than the acknowledged actual earth quadrant, according to the best determinations; but the fact of the latter being 10,001 kilometres, instead of 10,000, is a matter of precision in definition only, and in no way affects the practical unit.

As regards the history of the subject, it would appear that prior to 1887, measurements and deductions were confined to scientific works, and were expressed in absolute units—centimetres. In that year, however, a paper was read before the British Institution of Electrical Engineers by Messrs. Ayrton and Perry,† who invented and developed a practical measuring instrument for the measurement of inductance, who, aided by Dr. Sumpner, made important contributions to the literature of the subject, and who proposed a name provisionally for the practical unit. That name was the secohm, a contraction of second-ohm, implying the fact that the product of the two was the length equal to the practical unit. They drew attention to the fact that since the Paris Congress of 1884 had fixed the standard legal ohm as the resistance of a column of mercury at zero centigrade, 106 centimetres long and one square millimetre in cross section, whereas the true ohm was in all probability 105.3 centimetres, or one-quarter of one per cent. greater, the inductances measured in the manner they suggested from seconds and legal ohms would be in terms not of the standard earth quadrant of 10,000 kilometres, but of legal earth quadrants 9,978 kilometres in length. The difference practically is not very great, but to avoid error or confusion in definition, they advocated provisionally the term secohm in place of quadrant.

The Paris Congress of 1889 adopted the "quadrant" as the practical unit of inductance, defining it as 1,000 million centimetres.

The practical range of inductances is second only to that of resistances, and the latter we know from a few microhms up to the thousands of megohms. The smallest inductances are those of Hertz resonators which descend to the order metres. Excluding these, however, the smallest are perhaps met with in measuring instruments intended to have negligibly small inductance, such as doubly-wound resistance coils, Cardew voltmeters and the like. These descend to the order of decametres and can generally be expressed as such without prefixing decimal points. It is evident that the term microhenry would suitably apply to their designation. At the other end of the scale we find large induction machines linking dense fields with many turns of wire and reaching inductances of hundreds or even thousands of henrys. Intermediate between these limits there exists a large class of circuits having many turns but little iron, or clad in iron with few turns of wire, and these seem to be best expressed by the term millihenry, equivalent to the myriametre.

With the object of setting forth the advantages to be derived from the use of this nomenclature, it may be permissible to adopt it provisionally in describing the measurements that follow. These measurements have been made in different types of apparatus at different times and by different methods, so that they represent mean values from several observations in many cases, but allowance must be made for variations of standard and type.

In telegraphy, the inductance of an ordinary Western Union 140-ohm relay is about three henrys, with the

* A paper read at the 52d meeting of the American Institute of Electrical Engineers, New York, Dec. 16, 1890.
† *Phil. Mag.*, Feb., 1889, series v., vol. xxvii., p. 104.
‡ *Phil. Mag.*, June, 1888., series v., vol. xxv., p. 453.
§ "The Alternate Current Transformer," by J. A. Fleming, vol. i., p. 55.

* *The Electrician* (London), Sept. 19, 1890, p. 558, Report of British Association Discussion.
† *Journal of the Institution of Electrical Engineers* (London), April, 1887, vol. xvi., p. 291.

armature drawn well back, and nine henrys with the armature pressed against the poles; in the latter case, of course, the magnetic reluctance of the iron circuit is a minimum, and the same current in the coils causes three times as many lines to circulate through the iron. At the position of the armature in ordinary adjustment the inductance is about five henrys.

The inductance of an ordinary standard 10 ω relay is from 200 to 500 millihenrys, according to the position of the armature relatively to the poles.

The inductance of an ordinary sounder is similarly from 25 to 50 millihenrys. These inductances are the values obtained with only a few milliampères through the coils, and since the path of the induction is largely through iron, the inductance varies with the strength of the current used. Practically, however, the variation is small within the range of current at which instruments usually operate.

SUBMARINE TELEGRAPHY.

The inductance of a mirror speaking galvanometer of the ordinary type having 2,250 ohms was found to be 3.6 henrys.

TELEPHONY.

The inductances met with in the ordinary long distance telephone apparatus are as follows:

The call bell 80 ohms and 1.4 henrys.

The magneto armature 550 ohms, and from 2.7 henrys with the plane of the coil in the line joining the poles to 7.3 henrys when the iron core joins the poles, the plane of the coil being then at right angles to the magnetic flux.

The induction coil primary 0.28 ohm and 3.5 millihenrys.

Secondary 164 ohms and 734 millihenrys.

The mutual inductance between the coils 60 millihenrys.

The Bell telephone receiver 75 ohms and from 75 to 100 millihenrys. The removal of the diaphragm from an ordinary telephone of this type reduces the inductance about 35 per cent. All these inductances are to currents of a few milliampères only. As regards the inductance of aerial line wires, it to be regretted that measurements are not yet forthcoming, and indeed the experimental determination is attended with some difficulty, owing to static capacity and imperfect insulation. In the absence of direct measurements, theory indicates that the inductance of overhead copper wires depends upon the elevation above the ground as well as upon the diameter. In the case of iron wires as used in telegraphy, the permeability of the iron enters as an additional factor. The following table of inductances for copper wires is based upon a formula first given by Clerk Maxwell.* It is to be hoped that experimental evidence may shortly be collected corroborating these results:

TABLE OF INDUCTANCES OF COPPER AERIAL LINE WIRE, PER KILOMETRE AND MILE FOR DIFFERENT DIAMETERS AND ELEVATIONS ABOVE THE GROUND.

| Diameter of wire. | | Elevation above ground 400 cms., or 15.1 ft. | | Elevation above ground 700 cms., or 23 ft. | | Elevation above ground 1,000 cms., or 32.8 ft. | | Elevation above ground 1,300 cms., or 42.7 ft. | |
|---|---|---|---|---|---|---|---|---|---|
| Centimetre. | Inches. | Millih'nrys or myriametres. | | Millih'nrys or myriametres. | | Millihenrys or myriametres. | | Millihenrys or myriametres. | |
| | | Per kilomet. | Per mile. | Per kilomet. | Per mile. | Per kilomet. | Per mile. | Per kilomet. | Per mile. |
| 0.10 | 0.039 | 1.986 | 3.196 | 2.109 | 3.393 | 2.170 | 3.493 | 2.222 | 3.576 |
| 0.20 | 0.079 | 1.848 | 2.974 | 1.960 | 3.154 | 2.031 | 3.268 | 2.083 | 3.352 |
| 0.30 | 0.118 | 1.766 | 2.842 | 1.878 | 3 022 | 1.950 | 3.138 | 2.002 | 3.222 |
| 0.40 | 0.158 | 1.709 | 2.750 | 1 821 | 2.930 | 1.892 | 3.045 | 1.945 | 3.130 |
| 0.50 | 0.197 | 1.664 | 2.678 | 1.776 | 2.858 | 1.847 | 2 973 | 1.900 | 3.058 |
| 0.60 | 0.236 | 1.628 | 2.621 | 1.740 | 2.800 | 1.811 | 2.914 | 1.863 | 2.998 |
| 0.70 | 0.276 | 1.596 | 2.569 | 1.709 | 2.750 | 1.780 | 2.865 | 1.833 | 2.950 |
| 0.80 | 0.315 | 1.570 | 2.527 | 1.682 | 2.706 | 1.754 | 2.823 | 1.806 | 2.906 |
| 0.90 | 0.354 | 1.547 | 2.489 | 1.659 | 2.669 | 1.730 | 2.785 | 1.783 | 2.870 |
| 1.00 | 0.394 | 1.526 | 2.456 | 1.638 | 2.635 | 1.709 | 2.750 | 1.761 | 2.834 |

The inductance of iron wires, in the absence of measurements, is almost too doubtful to justify calculation, being, perhaps, 10 times more than the inductance of copper wires under similar conditions. The difficulty in their case lies in assigning the proper value of permeability.

ELECTRIC LIGHT AND POWER.

Dynamos and dynamo-electric machinery are, of course, generally characterized by large inductances.

The inductance of the field magnets of a dynamo may have any value depending on the size and voltage of the machine from one henry up to 900 henrys.

The inductance of an armature may similarly vary from 20 millihenrys up to 50 henrys between brushes. One millihenry is a fair average value of the inductance of one section of an armature. Armature inductances depend not only on the strength of the measuring current, but also upon the strength of the field, and whatever influences the permeability of the core.

The inductance of an alternating transformer varies from a primary of 400 millihenrys, a secondary of one millihenry and mutually 20 millihenrys with a transformation ratio of 20, up to corresponding values perhaps one hundred times as great.

APPARATUS—THE INDUCTANCE OF RUHMKORFF COILS.

The smallest medical coil in ordinary use has five millihenrys in its primary, 100 millihenrys in its secondary, and 20 millihenrys mutually between them.

*Clerk Maxwell. "Electricity and Magnetism," second edition, vol. 1, p. 293.

A large induction coil 19 inches long and eight inches in diameter has 0.145 ohms and 13 millihenrys in its primary, 30,600 ohms and 2,000 henrys (by two concordant methods of measurement) in its secondary, and 163 henrys mutually between them.

The inductance of a mirror galvanometer may vary from a few millihenrys up to 10 or more henrys, according to its resistance. Two henrys is a fair average for an astatic mirror galvanometer of 5,000 ohms.

An ordinary electric bell of 2.5 ohms resistance was found to have an inductance of 12 millihenrys.

There is one point in connection with the self and mutual inductance of induction coils and transformers that deserves attention owing to the confusion that occasionally arises concerning it. It may be, perhaps, best represented by a numerical example. Let a closed Faraday ring of iron 100 centimetres in mean circumference and 20 square centimetres in uniform cross section, be closely wound with a primary coil of 2,500 turns in one layer, followed by a secondary coil of 7,500 turns also in one layer. If now, two ampères be maintained steadily through the primary, the magnetic force in the iron will be $4\pi/10$ times the ampère turns per centimetre of the iron circuit, or $4\pi/10 \times 2 \times 2{,}500 \div 100$, or 62.85. The permeability of wrought iron at this force being, say 250, the induction developed per square centimetre will be $250 \times 62.85$, or 15,713 lines, and the total induction enclosed by the primary coil, neglecting the space occupied by the wire itself will be $20 \times 15{,}713$, or 314,250 lines which traverse every turn of both windings. The linkages with the primary will be $2{,}500 \times 314{,}250$, or in round numbers, 786,000,000, and referred to one absolute unit of current (ten ampères) five times this number, or an inductance of 3,930 million centimetres, that is 3.93 henrys. Similarly the linkages of these lines with the secondary will be 2,358 millions, and for ten ampères of primary current 11,790 millions of centimetres mutual inductance, or 11.79 henrys. Next suppose the primary current interrupted, and a current steadily established in the secondary sufficient to produce the same magnetic force in the iron, thus avoiding the complication of a changing permeability. As the secondary has three

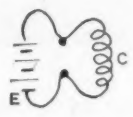



FIG. 2.

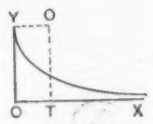



FIG. 3.

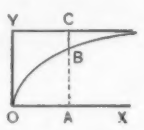



FIG. 4.

times as many turns, the current effecting this will be two-thirds of one ampère. The total induction through the iron will now be the same as before, and therefore the linkages will be equally numerous. The self-inductance of the secondary will be $2{,}358{,}000{,}000 \div \frac{2}{10}$, or 35,370,000,000 centimetres, that is 35.37 henrys. The mutual inductance will similarly be $786{,}000{,}000 \div \frac{2}{10}$, or 11.79 henrys as before. It will be found on carrying the reckoning to the necessary degree of accuracy, that this mutual induction, 11.79, is the square root of the product of the two self-inductances, $3.93 \times 35.37$.

Examination of the steps in this calculation will show that this proposition must hold for all closed magnetic circuits uniformly magnetized to the same degree when the space occupied by the windings is not taken into account. Under the opposite conditions of open and especially of short iron cores, with large winding spaces, the condition usually fails, and the mutual inductance may be greater or less than the square root of the self-inductances multiplied together.

Another reason in favor of selecting 1,000 million centimetres as the value of the practical unit or henry, is the desirability of having the time constant of an electromagnetic circuit expressed directly in seconds by its practical units as in the case of electrostatic circuits, rather than revert to a unit of inductance that would yield the time constant in milliseconds or other fractional period of time. The time constant of a simple electromagnetic circuit, a circuit having inductance and resistance, but negligibly small electrostatic capacity, is defined as the ratio of its inductance to its resistance, that is of its henrys to its ohms. It is an important function, and its consideration presents some remarkable analogies between inductance and electrostatic capacity that it is interesting to trace.

Imagine an inductance coil $C$ without iron to be supplied with a steady current from an electromotive force $E$ of 50 volts. Let the inductance of the coil be three henrys, and its resistance 10 ohms. (Fig. 2.) Ohm's law determines the strength of the current to be five ampères. Now short-circuit the terminals of the coil very suddenly by a wire across its terminals of negligible resistance. The current in the coil $C$ does not stop instantly, but under the name of extra current is maintained in the coil by reason of its inductance. According to theory, the last dregs of the current will never entirely vanish from the coil, although after the first few seconds the remainder is exceedingly small. The very first instant after short-circuiting, the current continues at five ampères by its electromagnetic momentum, but being unsupported, its energy is lost thermally in overcoming the coil's resistance, and it immediately falls. In falling, the lines of force linked with the circuit and sustained by the current are drawn in, cutting the coil as they recede, thus creating a counter E. M. F. tending to prolong the current, and this process of dwindling current with reduction of opposition from the reserve of inductance descend together. The total quantity of electricity that will flow through the circuit under the conditions specified may fairly be called the charge or discharge of the coil, and it can be readily proved that this charge is equal to the quantity that would be conveyed by the initial discharging current, acting uniformly during a time equal to the time constant of the circuit. In this case the discharge commenced at five ampères, and the time constant is 0.3 second, so that the total discharge will be that due to the flow of this current in 0.3 seconds, that is 1.5 coulombs.

To represent the case graphically, suppose the curve of discharge in time to be plotted as in the figure. Let the axis $OX$ be divided off into seconds, and the axis $OY$ into ampères. (Fig. 3.) The discharge commences at five ampères, subsides rapidly at first, but at last so slowly that an indefinitely long time must elapse before it altogether disappears. The area enclosed between the curve and the axes represents ampère-seconds or coulombs to the amount of the total charge, and the proposition just stated asserts that if the current had continued at five ampères steadily for 0.3 second the area of the dotted rectangle so generated $YDTO$ would be equal to the total area enclosed between the curves and the axes prolonged to the ultimate point of union.

Curiously enough, exactly the same law applies to the discharge of a condenser through a circuit of resistance but negligibly small inductance, the time constant of the circuit in this case, however, being its capacity in farads multiplied by its resistance in ohms.

The curve of discharge is of the same type for inductances or capacities. It is logarithmic, and finds its prototype in the case of the discharge of water in time, from a tank having a faucet at the base, assuming that the rate of escape through the faucet at any moment is directly proportional to the pressure, or level of water then remaining in the tank.

The laws which control the outline of this discharge curve are identical for condensers or short-circuited inductances, and are combined in the following enunciation:

The natural logarithm of the ratio of the $\left\{\begin{matrix}\text{full charge}\\ \text{initial current}\end{matrix}\right\}$ to the $\left\{\begin{matrix}\text{residual charge}\\ \text{discharging current}\end{matrix}\right\}$ at any instant is the quotient of the time during which discharge has been in progress by the time constant of the circuit.

In this statement two reservations are necessary.

The electrostatic circuit must be free from all appreciable inductance, and the electromagnetic circuit must contain negligibly small electrostatic capacity. It was first pointed out by Sir William Thomson that the discharge of a condenser through an inductance circuit becomes oscillatory when the inductance exceeds a certain critical value.

When an inductance discharges through a break instead of a closed circuit, the conditions become complicated to a degree that eludes complete practical solution in the present state of knowledge.

At the period of natural discharge equal to the time constant, an inductance or capacity charge or current will have fallen to 36.8 per cent. of its initial value.

Similar propositions relate to the charging currents and quantities. In the above instance, after the coil has completely discharged, remove the short-circuiting wire. The current will immediately enter the coil, and the curve of its arrival in time is represented in Fig. 4, this curve being only an inversion of the preceding. For this reason it is evident that the area above the curve now represents the charge, and by an extension of meaning the deficit from full current, such as $B\,C$, may be called the charging current, since on discharge and reversal of the diagram this will be the discharging current at the same lapse of time. In fact, the current $A\,C$ is doing work in heating the coil, the deficit from ultimate current $B\,C$ being only active in increasing the electromagnetic momentum of the circuit, and work is really stored in the coil as though the deficit current did exist. A similar but inverted curve of current in time represents the charge of a condenser. In each case and under the above restrictions the following propositions hold:

The natural logarithm of the ratio of the $\left\{\begin{matrix}\text{full charge}\\ \text{initial current}\end{matrix}\right\}$ to the $\left\{\begin{matrix}\text{deficit from full charge}\\ \text{charging current}\end{matrix}\right\}$ at any instant is the quotient of the time during which the charge has been in progress by the time constant of the circuit.

When the charging interval reaches the time constant the charge will have attained 63.2 per cent. of its full value.

Another relation between simple electrostatic or electromagnetic circuits and their time constants is in their stores of energy. The energy of the charge in each case is half the energy that would be developed by the initial charging or discharging current against the ohmic resistance of the circuit in the time equal to the time constant. In the above instance, for example, five ampères being the initial charging or discharging current, and the resistance 10 ohms, the circuit energy of this current per second would be $5 \times 5 \times 10 = 250$ joules, and during half the time constant the energy thus developed would amount to $0.3 \times 250 \div 2$, or 37.5 joules. This is the electromagnetic energy stored up in the charge.

These are not the only analogies that exist between inductance and capacity, but there are remarkable points of

diversity. The discharge of extra current of a coil is in the same direction as the circuit current; with the condenser it is the reverse. In a great many practical instances, the electromagnet and the condenser are used to annul each other's influence.

The time constant of an inductance circuit is generally small for the reason that a coil of large inductance has generally many turns and therefore high resistance, so that the ultimate ratio of the henrys to the ohms is not large. For example, the time constant of a Bell telephone, considered in itself or on short circuit, is from the measurement above described, about 0.09 ÷ 75, or 0.0012 seconds; and therefore a steady E. M. F of say two volts impressed directly upon such a telephone would produce in this interval of time 63.2 per cent. of $\frac{2}{75}$ ampères, namely 169 milliampères. By adding inductanceless resistance to the circuit, however, and raising the E. M. F. proportionately, the time constant would be lessened, and the arrival of current accelerated. Strictly speaking, this reasoning is inaccurate, since the telephone coil surrounds iron, but with the small currents usually employed the iron probably does not greatly influence the arrival curve. In the case of dynamo field magnets, and large ironclad inductances generally, the divergence of the arrival curve from that of a corresponding simple electromagnetic circuit is considerable.

There are several methods by which self and mutual inductance can be measured, the selection depending on the magnitude to be determined and its nature. The Ayrton and Perry secohmmeter or double revolving commutator is perhaps the most generally useful. It may be employed in connection with a standard condenser, a standard inductance, or apparent change of resistance with speed. Being used in the Wheatstone bridge, the currents it can alternate are necessarily limited in strength.

For small inductances,* say less than one-tenth of a millihenry, the method of Prof. Hughes,† or its modification by Lord Rayleigh, is probably best suited, using two coils of mutual inductance and a telephone as the observing instrument.

The inductance coils are usually in the form of two concentric rings, the inner being capable of rotation about the common vertical. The mutual inductance of such a pair of coils is a complex function of the dimensions and the angle between the planes at which the coils may be set. It is usual to calibrate the instrument by separate measurements of the inductance at different angles. A simpler arrangement, however, for mutual inductance is a short solenoid in the bridge circuit superposed coaxially upon a long solenoid in the battery circuit. Adjustment to silence in the telephone for interrupted currents is then made by including in the bridge circuit a greater or less number of turns in the outer solenoid. The mutual inductance is then very nearly proportional to the number of turns so included, and by suitable proportions in construction the accuracy can be carried as far as the telephone or the receiver will permit.

For the measurement of inductance in coils on iron machinery, the ballistic galvanometer is frequently employed, either by the method of discharge for self-inductances, or induced quantity with mutual inductances. Mutual inductances connected by closed iron circuits present no difficulty when great accuracy is not required, since, as already observed, the self-inductances are calculable in these cases when the mutual inductance and the number of turns in the coils are known. It is much more difficult, however, to measure the self-inductance of the field magnet of a dynamo when the armature is removed, and when currents of the normal exciting strength are used in the measurement. The best attempt has been made apparently by observing the discharge effects of gradual small changes of a strong current passing through the coil, in circuit with a specially arranged Wheatstone bridge.‡ If it were of sufficient practical importance, however, to measure such inductances with powerful currents, a recording instrument might be tried, having a very light and swiftly moving pointer, leaving a trace of its motion on a strip of moving paper like Sir William Thomson's siphon recorder. If such a pointer were arranged to give an amplitude of movement at right angles to the paper strip, in proportion to the current traversing the coil, it would register the curve of discharge when the coil was short-circuited in the manner described above. On a sufficiently enlarged scale, corrected, perhaps, for residual inertia in the moving parts, this curve would give not only the total quantity of discharge, but its deviation from the logarithmic line of simple electromagnetic discharge would give the means of determining the characteristic of magnetization in the iron.

Of far lesser importance than the selection of the practical inductance unit, but still well worthy of separate consideration is the selection of appropriate symbols to represent the unit briefly. It might, perhaps, be advantageous to represent the henry by a capital H, and the millihenry by the plain letter h. This notation would enable such an inductance as 50 henrys to be written as 50 H, and 50 millihenry as 50 h. The microhenry occurs so seldom that it would probably not need a symbol.

All measurements of precision should employ true ohms and not legal ohms in the computations. The best existing value of the true ohm is 1.0028 legal ohms.*

The correction is practically so small that it can best be carried out by altering the nominal standard temperature of the resistance coils adopted. These temperatures should be increased by 9.4°C. for platinum silver, 6.5°C. for German silver, and 13.5°C. for platinoid. Thus a resistance box with platinum coils standardized for legal ohms (of 106.0 centimeters) at 15°C. would give true ohms of 106.3 centimeters at 24.4°C. as the best approximation. and this would be the standard temperature of the box for use in precise measurements of inductance.

* *Journal of Institution of Electrical Engineers* (London), Jan., 1886.

† For another method of measuring small inductances with an alternating current, see an article by C. Steinmetz in the *Electrical Engineer*, vol. x, Nos. 130, 131, Nov., 1890.

*Phil. Mag.*, Feb., 1889. Dr. Sumpner.

## Coupling Alternators in Series.†

BY PAUL BOUCHEROT.

The fact is well known that if two alternate-current machines are connected terminal to terminal the electromotive forces tend to become opposed to each other.

The explanation of this phenomenon has been given by Dr. John Hopkinson. At the moment of coupling there is always a difference of phase, however small it may be, between the E. M. Fs. of the two dynamos; from this

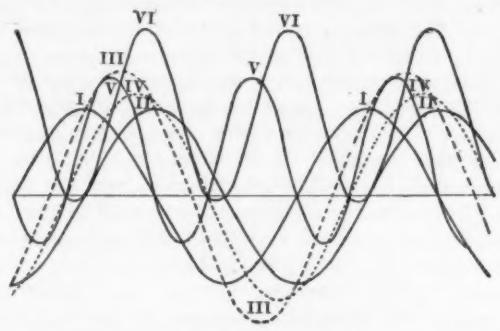



Fig. 1.—Particulars of Two Alternators at the Moment of Connection, Terminal to Terminal.

I. E. M. F. of forward dynamo. II. E. M. F. of backward dynamo. III. Total E. M. F. IV. Current resulting from total E. M. F. V. Energy produced by forward dynamo. VI. Energy produced by backward dynamo.

results (see Fig. 1) a total E. M. F. whose maximum values are, in time, at equal distance from the maximum values of each E. M. F.; in other words, a total E. M. F. which has, as difference of phase between itself and each of the E. M. Fs., half the difference of phase existing between themselves. The strength of current which results from this total E. M. F. lags somewhat behind, owing to the self-induction, and its curve approaches more nearly to that of the E. M. F. of the backward dynamo than to that of the other.

It results from this that the energy produced by this dynamo is the larger, which again contributes towards increasing its lagging until the moment when the two E. M. Fs., separating more and more, at last become in actual opposition. In a word, the opposition of the E. M.

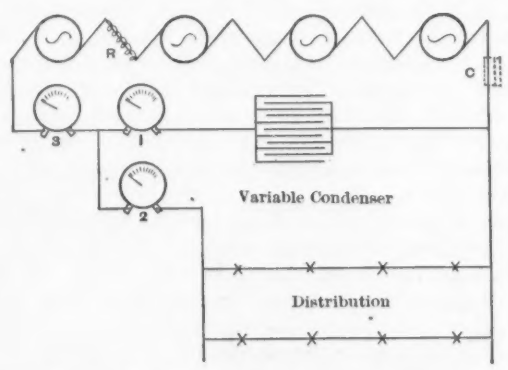



Fig. 2.—Coupling Alternators in Series.

It is sufficient that the electro-dynamometer 1 indicates as much as the electro-dynamometer 2. The electro-dynamometer 3 then gives an approximate idea of the amount of self-induction in the distributing circuit. The dotted condenser shows the position of the fixed condenser mentioned afterwards.

Fs. is a stable equilibrium, their superposition is an unstable equilibrium.

It is, therefore, only by reason of the gradual dwindling of the current strength behind, a dwindling produced by the self-induction, that this coupling in opposition takes place automatically. It is easy to conceive that, if instead of a dwindling behind, there were to be a dwindling in front—and a condenser placed in circuit will give this result (*L'Electricien*, Nov. 15, 1890)—then the E. M. Fs. would group themselves in series; the curve of current strength approaching more nearly to the curve of E. M. F. of the forward dynamo than to that of the other, the energy of this dynamo will be the greater, which will tend to retard it, until that moment when the E. M. Fs. approaching each other more and more at last are superposed.

The superposition of the E. M. Fs. will then be a stable equilibrium and their opposition an unstable equilibrium.

To group alternators in series then, all that is necessary to do is to introduce in their circuit a capacity *weak* enough to destroy the self-induction, and at the same time to reduce sufficiently the current strength, but *strong* enough not to have too large a C. E. M. F. and not to diminish too much the available difference of potential.

As with the self-induction so with the current strength. The greater the reduction (that is the smaller $C$ becomes) the better the coupling will take place, but also the more the available difference of potential in full work will be diminished.

But there is no allusion to be made about this expedient, since it completely forbids the use of apparatus which, like transformers, only work usefully by reason of their self-induction, as it is necessary to destroy this.

It is, therefore, necessary to diminish first the current strength in the machines without changing the respective position of the phases in the distributive circuit. This will be brought about by placing the condenser as shunt to the terminals of the distributing circuit (see Fig. 2). But the necessary capacity is no longer determined by the relation $\omega^2 L C < 1$. This is not only a function of the self-induction of the distributing circuit, it is also a function of its resistance.

The current in the distributing circuit is

$$I_t = E_{\max} \frac{R \sin \omega t - \omega L \cos \omega t}{R^2 + \omega^2 L^2}$$

and that in the condenser

$$I' = E_{\max}\ \omega C \cos \omega t$$

The total intensity is therefore:

$$E_{\max} \left( \frac{R \sin \omega t}{R^2 + \omega^2 L^2} + \frac{(R^2 + \omega^2 L^2)\, \omega C - \omega L}{R^2 + \omega^2 L^2} \cos\ \omega\ t \right)$$

and for this current strength to be in advance, the coefficient of cos $\omega\ t$ must be positive—that is, that we must have:

$$C < \frac{L}{R^2 + \omega^2 L^2}$$

Now this condition can be realized in a simple manner, without knowing either the self-induction or the resistance of the distributing circuit.

It is sufficient, by varying the capacity, to maintain the available current strength in the condenser equal to the available current strength in the distributing circuit.

In fact, in the condenser

$$I'_{av} = E_{av}\ \omega C,$$

and in the distributing circuit

$$I_{av} \frac{E_{av}}{\sqrt{R^2 + \omega^2 L^2}}$$

By making these equal we get

$$\omega C = \sqrt{\frac{1}{R^2 + \omega^2 L^2}} = \frac{\sqrt{R^2 + \omega^2 L^2}}{R^2 + \omega^2 L^2};$$

and, as $\sqrt{R^2 + \omega^2 L^2}$ is always greater than $\omega L$, we get

$$\omega C > \frac{\omega L}{R^2 + \omega^2 L^2}.$$

The solution is, therefore, simple. It is not, moreover, too costly. Suppose that it is desired to group in series five machines of 500 volts and 25 ampères in order to obtain a pressure of 2,500 volts. A variable condenser of a maximum capacity of 20 microfarads will suffice for all the requirements of working. The microfarad condenser of commerce to resist a pressure of 2,500 volts will cost about 20 . This is not an excessive expense. It might be considered sufficient to put a condenser of the constant capacity of 20 microfarads upon the machines, but the strength of current would always be from 20 to 25 ampères. whatever the expenditure in the distributing circuit, and this would be less advantageous by reason of the $r I^2$ lost in the armature. For the rest, it is a slight inconvenience of this proceeding to make the $r I^2$ lost in the armature larger than it would be without condenser. The available strength of current in the armature is, in fact, equal to the available strength of current in the circuit multiplied by

$$\sqrt{2 - \frac{2\ \omega L}{\sqrt{R^2 + \omega^2 L^2}}}$$

and unless $R$ is nil it is always larger than this latter. The largest ratio there can be between the two is $\sqrt{2}$ for $L \doteq 0$. The loss of energy in the armatures can therefore attain to twice the value it would have without a condenser.

If it is not desired to allow so great a loss and to rely upon a smaller reduction, it would be necessary to know the reduction, $\varphi$, in the backward direction of the distributing circuit, and to make the available current strength in the condenser rather larger than the product of the available current strength of distribution by sin $\varphi$.

But in these calculations the dynamos to be coupled are supposed to be without self-induction, which is the case only in theory. In practice, the dynamos always having some self-induction, this must be kept in view. Two cases, then, have to be considered. The network of distributing mains may be variable in resistance and self-induction, or it may be constant. In the first case, it is always preferable to bring all to the theoretical case in which there is no self-induction, and this by destroying the effects of this self-induction by a constant condenser, $c$, such that $\omega^2\ l\ c = 1$, placed in the circuit of the dynamos (see dotted lines Fig. 2). Not having at each instant any idea of $R$ and of $L$ of the distributing circuit, there can be no simple process for reducing the forward current strength with the sole aid of the condenser, $C$, placed in shunt upon the distributing circuit; by the addition of the condenser $c$, all

* Report of the Committee on Electrical Standards read before the British Association, September, 1889. See *The Electrician* (London) of Sept. 28, 1890.

† From the London *Electrical Engineer*.

that is necessary to maintain the series coupling is to vary $C$ at the same time that $R$ and $L$ vary in the distributing circuit, so as to have the available current strength in the condenser always equal to the available current strength of the distributing circuit.

The addition of this condenser $c$ is not very costly, and, besides, its cost would be regained by the added useful energy of the machines.

When the values of the resistance and of the self-induction are known, one single condenser in shunt on the circuit may be enough. A long calculation, which it is not necessary to reproduce here, shows the condition found, in order that the current strength shall be reduced in advance, to be

$$\frac{R^2\ \omega\ C\ (1-\omega^2\ l\ C)}{\omega\ L+\omega\ l\ (1-\omega^2\ L\ C)}+\omega^2\ L\ C>1,$$

from which the extreme limits of $C$ may be found.

In fine, if the values of $L$ and of $R$, although variable, always satisfy the condition $R>\omega L>2\omega l$, or even to this other condition, more complicated but less exacting, $R^2\ (2\omega L-\omega l)>\omega^2 L^2\ (\omega L+\omega l)$, it is sufficient to vary the condenser in such a way that the available current strength in its circuit shall be always equal to the total available current strength which flows in the coils, which leads to the result of making $\omega^2 L\ C=1$.

## Resistance Coils and Boxes: Their Construction and Use.

BY CHARLES P. FREY, CHIEF ELECTRICIAN OF THE GREELEY ELECTRICAL LABORATORY.

II.

In the preceding article on this subject, a description of a rheostat, occasionally called a "plug-in" box, was given. Figs. 4 and 5 illustrate "plug-out" boxes, which are very frequently employed, this term being used because plugs are removed instead of being shifted, to increase the total resistance. Each of these has rheostat coils aggregating 10,000 ohms. The larger of the two has, however, six additional coils forming a "bridge." These when used with the rheostat coils permit measurements to be made within a range of from $\frac{1}{100}$ ohm to 1,000,000 ohms. This box is to be used in connection with some sensitive galvanometer, preferably of the Thomson pattern, which will give the best results if wound to a resistance of from 5,000 to 25,000

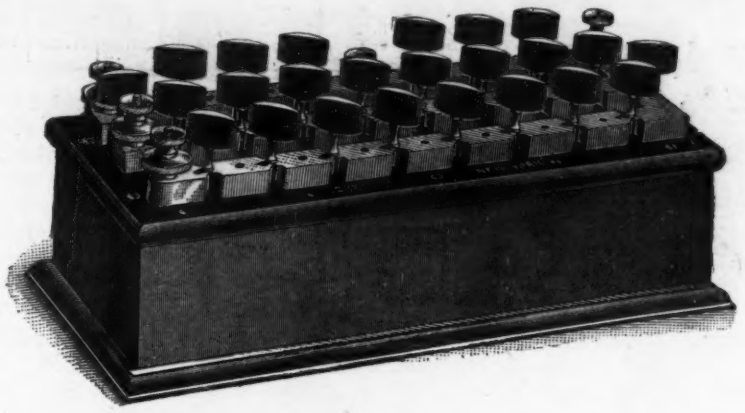


FIG. 4.

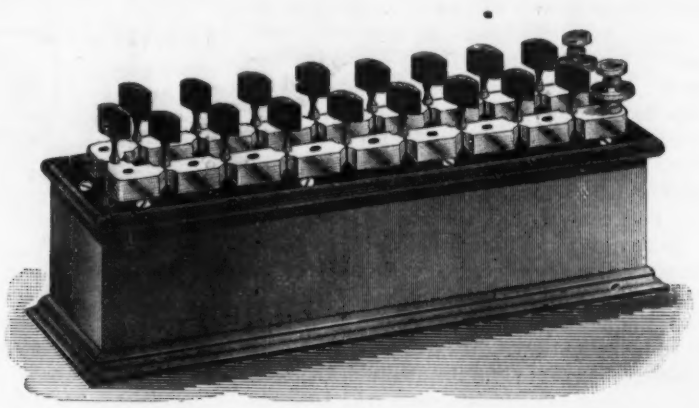


FIG. 5.

FIG. 7.

ohms, the preferred resistance depending on the nature of the work undertaken. When connected as shown on Fig. 5, it is arranged for resistance measurement on the Wheatstone's bridge principle. It will be noted that a shunt box is employed with the galvanometer, the use of which will be explained in a subsequent article on galvanometers.

To prevent as much as possible any inaccuracy due to heating the resistance coils by the current from the battery, the circuit should be closed for the briefest possible time, which is best accomplished by the introduction of a double contact key, which is connected as shown, so that the galvanometer circuit will be broken first. The resistance to be measured is connected at the double-headed binding posts at the extremes of the S-shaped brass bars. It will be found most convenient to fasten the battery and galvanometer connections under the lower nuts, reserving the upper for the resistance to be measured. In all preliminary or rough measurements, the plug in the shunt box should be placed in the hole marked $\frac{1}{10}$ to avoid too violent throws of the galvanometer needle.

It is generally best, unless the resistance to be measured is known to be less than 1 ohm or more than 10,000 ohms, to begin with an even bridge, 100 ohms on each arm for instance. The bridge should in all cases have a resistance on each arm as nearly as possible equal to the resistance unplugged. When the direction in which the galvanometer needle swings has been noted, it will be easy to find out whether the resistance unplugged is greater or smaller than $X$ (the unknown resistance which is being measured), by varying $R$ (the box resistance), until the needle of the galvanometer swings in the opposite direction. It will be found convenient to connect the galvanometer so that a swing to the left means "large," which is easily remembered. In order to determine the value of a resistance as rapidly as possible, it is best not to make more than one or two random guesses, but to proceed in a systematic manner, on the principle of "halving." If a coil is being measured, and a preliminary test shows that it is more than one ohm and less than 400 ohms, it is evident that if various resistances are tried in turn, having no definite proportion to each other (although it may happen that the correct resistance will sometimes be quickly found by accident), as a rule such a process is tedious and unsatisfactory. Therefore, if one ohm is too small, and 400 ohms are too large, and we have as yet no other data, try at once the nearest intermediate resistance, 200 ohms. If 200 is also too large try 100. If 100 is too small add half the difference between 200 and 100, the box now reading 150. This being found too large try 125. If 125 is too small, try 135 or 140. Counting the number of tests we find that an unknown resistance has by eight observations been located between 135 and 140 ohms, and that one or two more trials will decide its exact value. To appreciate this method, it is only necessary to try guesswork, and count the number of tests in each instance. A resistance which lies between one ohm and 10,000 ohms can be determined in this manner to its nearest ohm in not more than 15 tests.

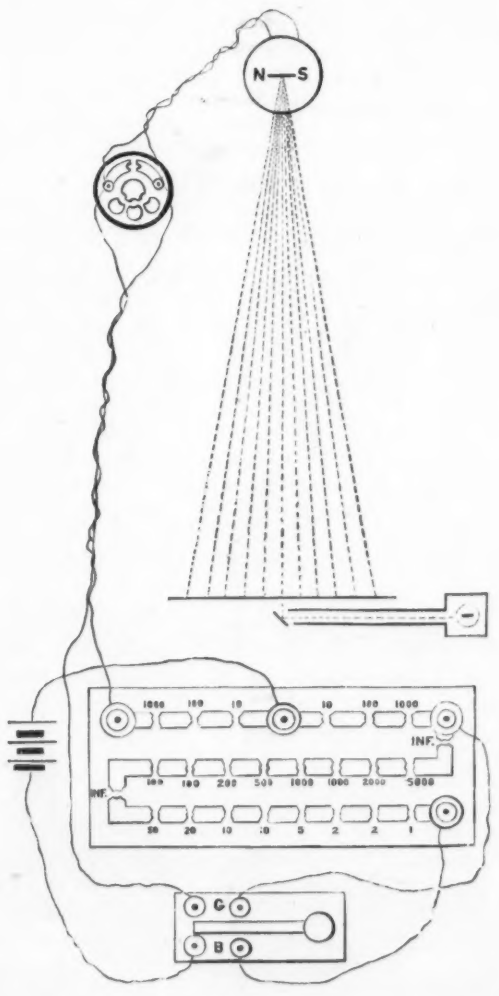



FIG. 6.

This rheostat is a standard instrument, its coils being correct at a given temperature, and the best results will be obtained by using the box at that temperature. The coils are ordinarily adjusted to be correct within one part in 5,000 to 10,000; $\frac{1}{50}$ to $\frac{1}{100}$ of one per cent.

Fig. 6 illustrates a resistance box of the English post-office pattern.

There is a little inside wiring in this box, but not enough to prevent it from being generally serviceable, or restricting its use to the measurement of resistances, as shown in Fig. 7.

There are two independent contact keys, one for galvanometer connections and one for battery wires. The dotted lines on the illustration show the path of the inside connections. They are shown on the instrument itself by white lines on the rubber top.

When used for measuring resistances, the coil or wire being measured is either connected directly with the binding posts at the extreme ends, or for convenience is fastened securely to copper conductors as shown, the resistance of which must either be allowed for, or made so low that it can be neglected.

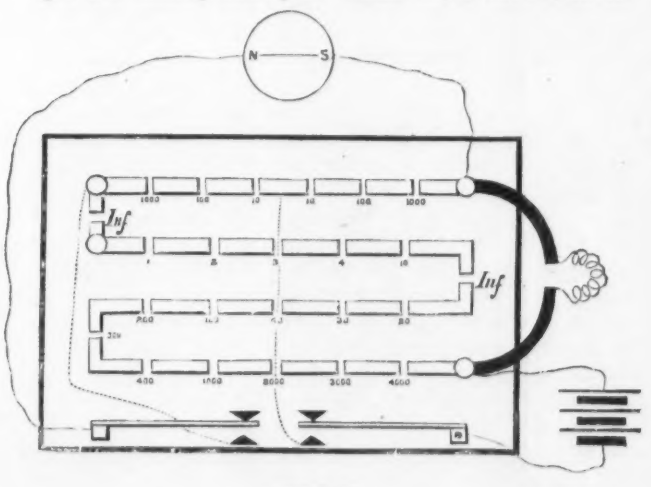



FIG. 8.

## Note on the Probable Explanation of a Peculiar Class of Faults Occurring in Submarine Cables.*

BY J. PARRY LAWS.

Some time ago I had my attention directed first by Mr. Saunders, of the Eastern Telegraph Company, and subsequently by Mr. Herbert Taylor, of Messrs. Clarke, Forde & Taylor, to a particular class of faults occuring in submarine cables. The distribution of these faults is decidedly limited, occurring, as they do, only in water having a moderately high mean temperature, and in positions where it is not very deep. When the core is examined it presents, strictly speaking, an appearance of simple decay, the gutta percha having undergone some chemical change, which renders it extremely brittle, and causes it to shrink in volume. I say chemical change advisedly, as there are no signs whatever of mechanical erosion; indeed, many of these faults are taken, I am informed, from parts of the cable where the outer covering of wire remained intact; the hemp, however, at the particular spot was entirely destroyed. These faults have therefore caused considerable speculation as to their origin, and the explanation I am about to suggest seems to me, on due consideration, to be at least feasible.

Taking into consideration the high temperature of the water, and the very limited position of these faults, I have come to the conclusion that they may probably be produced by the action of putrefying organic material either in actual contact with the cable or in close proximity to it. Guided by this hypothesis, I made some experiments on a laboratory scale to determine whether organisms, such as occur in putrefying fluids, or the products of their life, would have any effect on the core of submarine cables. The few experiments I have made show conclusively that putrefaction does exert a very marked effect upon gutta percha, some classes of putrefaction producing more effect than others. The few experiments I have been able to

*From *The Electrician* (London).

carry out are certainly confirmatory of the above suggestion, the gutta percha being considerably eroded and pitted after remaining in a putrid fluid for some time.

I hope to make experiments in greater detail, and publish the above as a mere suggestion, in the hope that others may collect facts tending to establish or disprove it.

### The Keystone Motor.

In the design of motor shown in the accompanying illustration, the makers have endeavored to produce a machine of full rated power, of compact form, simple in construction and entirely self-regulating. It is manufactured by the Keystone Electric Company, of Erie, Pa. As will be seen from the illustration it is of the two-pole type with an armature of relatively large diameter and comparatively short in the direction parallel to the axis. The upper yoke is attached to the field cores by large bolts, the surface of the joint being first carefully planed so as to give an accurate and smooth surface for contact. The commutator has a large number of sections and the brushes have ample bearing surface. The machine is mounted upon a base that can be moved by means of the hand wheel shown in the cut, in a direction parallel to the length of the belt. Great care has been taken to secure the best and simplest construction of details both mechanically and electrically.

### The Boston Trolley.

The cars on nearly 50 of the electric railways now in operation in this country are equipped with the trolley which is shown in the accompanying illustrations. It is the joint invention of Messrs. Albert and J. M. Anderson, of 21 Hamilton street, Boston, and was designed and first manufactured by them in the spring of 1889 under the direction of Mr. W. D. MacQuesten for use on the cars of the West End Street Railway in Boston, while Mr. MacQuesten was superintending electrician of that road. In consequence of this fact the name of the "Boston" trolley was given to it. The aim of the designers was to produce a trolley that would possess the characteristics of great strength and lightness of parts above the base, to secure a durable wheel that could be easily and cheaply repaired, to provide springs that would keep as nearly as possible a constant pressure of the wheel against the wire under all conditions, and to make the trolley head of such a shape that no trouble would be experienced from its catching on the span wires when for any cause the wheel left the wire. How well these objects have been attained may be seen from the accompanying illustrations and description, and from the remarkable success of the trolley in actual practice in over 1,000 cars now equipped.

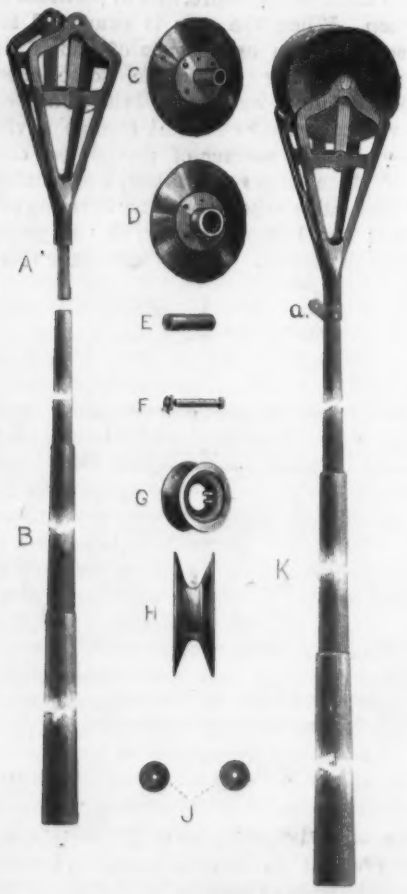
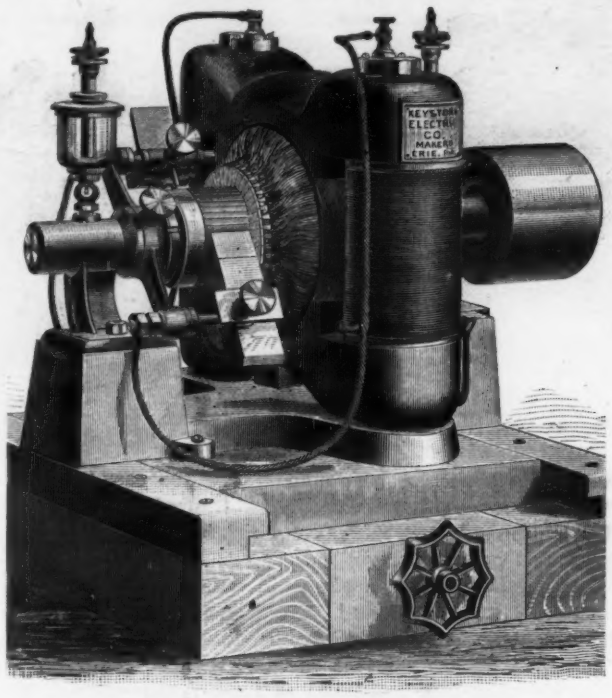



FIG. 2.—DETAILS OF BOSTON TROLLEY.

Fig. 1 shows the base of the trolley with the pole removed. It will be seen that the movement of the trolley pole in a direction parallel to the length of the car, whether forward or backward, brings the eight longitudinal spiral springs into tension. These springs are hung to the rocker arm by a method which provides in a very ingenious manner for maintaining a constant tension in all positions of the trolley arm. The forward and backward motion of the trolley arm brings into action the one or the other of two independent centres between the springs and the rocker arm, and this arrangement is such that a very slight motion in the trolley will put the springs under tension. The movement of the trolley pole at right angles to the length of the car is provided for by an axis of suspension at right angles to the main axis and by two spiral springs placed as shown in Fig. 1. All these springs have suitable adjustments for regulating the tension.

Fig. 2 shows the pole, which is made of steel tubing, in three sections, from one and a half to one inch in diameter. The wheel has a removable contact ring, shown at *G* in Fig. 2, which is held firmly between the two halves of




THE KEYSTONE MOTOR.

the wheel *C* and *D*, as shown at *H*. The projecting hub of *C* is threaded and screws into a corresponding threaded hub on *D*. The bearing of the wheel consists of a non-conducting bushing, such as rawhide, as shown at *E*, and is drilled for the steel axle pin *F*. The current is carried from the contact ring by means of contact springs which press lightly on the hub of the wheel. The frame holding the wheel is made of steel tapering in form to prevent catching in the span or pull-off wires. All parts of the trolley are interchangeable.

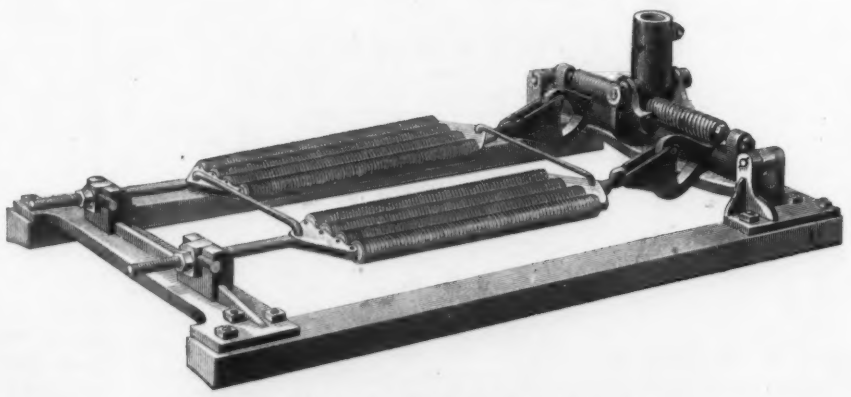


FIG. 1.—BASE OF BOSTON TROLLEY.

### The Capacity of Submarine Cables.*

BY HAROLD W. ANSELL AND JULIAN E. YOUNG.

In *The Electrician* of Sept. 5, Dr. Muirhead published a correction for the error in the determination of electrostatic capacities, arising from unequal rates of absorption in different dielectrics. The necessity of this correction, when the time of charge exceeds a few seconds, has long been apparent; and, as the figures in the paper alluded to show, it appears to achieve its object satisfactorily. Unfortunately, there are other sources of error in such measurements which have scarcely received the attention they demand. In the case of a cable, the leakage and retardation of the charge must be taken into account, as well as the rate of absorption, before the true capacity can be arrived at.

The following table is given with a view to showing the magnitude of the error introduced by moderate leakage laws of fall of charge, has been found sufficiently correct for practical purposes, taking *R*, in the case of a cable, as the dielectric resistance at the fifth minute.

| Time of charge | Leak. | Standard condenser. | Slide reading. | Log K. | Apparent capacity. | Corrected capacity. | True capacity. |
|---|---|---|---|---|---|---|---|
| Secs. | Megohms. | Mfs. | | | Mfs. | Mfs. | Mfs. |
| 2 | 1 | 19.2904 | 8074 | 0.011136 | 80.904 | 78.856 | 77.987 |
| 5 | 1 | " | 8127 | 0.027839 | 83.741 | 78.541 | " |
| 15 | 1 | " | 8312 | 0.083518 | 95.033 | 78.407 | " |
| 5 | 3.121 | " | 8060 | 0.008920 | 80.182 | 78.552 | " |
| 15 | 3.121 | " | 8120 | 0.026760 | 83.357 | 78.376 | " |
| 5 | 0.500 | 19.260 | 6120 | 0.217140 | 31.325 | 19.000 | 19.500 |

If the time of charge does not exceed two or three seconds, the correction for unequal rates of absorption (as Dr. Muirhead's) tables prove is so small that it may be neglected. It is questionable whether the time need ever be made to exceed three seconds, since this is all that would be required to overcome the retardation of long cables, that is to establish a practically uniform potential throughout the entire length of the conductor. This having been done, the cable may be regarded as charged-assuming the capacity as being that for receiving electri, city from the first contact, and as distinct from "electrification." On page 331 of Jenkin's "Electricity and Magnetism," fifth edition, a formula is given by which the time for any length of cable can be calculated.

Some uncertainty generally exists as to the real capacity of cables, more especially of long ones. Discrepancies are often met with between the values specified by manufacturers, those obtained immediately after submersion, and those observed at subsequent times. Since the localization of faults not infrequently depends on these last, the desirability of a more rigorous definition of capacity is evident. The following suggestions present themselves:—(1) That the true capacity of a cable should always be taken as the value of the instantaneous charge of one knot of its core, multiplied by the length of the line. (2) That, after submersion, the apparent value of the capacity should be taken to a fixed standard of time and method of observation, and corrected for the observed leakage by the formula given above, to reduce it to the value assigned by the foregoing definition.

With reference to the example given in the number of *The Electrician* already referred to, viz., the Porthcurno-Gibraltar cable, assuming that line to have a dielectric resistance of about five megohms at the fifth minute, which we understand is not far from the truth, the true capacity of that section would be about four microfarads less than 458.17.

$$\text{true capacity} = \frac{\text{apparent capacity}}{k},$$

$$\text{where} \quad \log k = \frac{t}{2.3026\ F\ R},$$

*t* being the time of charge in seconds, *F* the approximate capacity to be measured in microfarads and *R* the resistance of the leak in megohms. This expression, based on the *alone*, the condensers compared having similar dielectrics, and therefore absorbing at the same rate. The correction applied to the result obtained by balancing the potentials of the charges, according to the usual method, is as follows:

*From the *Electrician* (London).

### A Protector for Lamp Sockets.

In many places where incandescent lamps are used it is necessary to provide some means by which the socket may be made moisture proof. The accompanying illustration shows a device placed upon the market by the McCreary Electrical Specialty Company, of this city, intended for this purpose. In the figure *A* is a metal cap containing a rubber gasket; *B*, a metal shell which is adapted to any kind of socket, and *C* is a rubber neck covering the opening where the lamp is inserted. The advantages claimed for this protector are that while the light is unobstructed the socket is rendered moisture proof; that it will fit any lamp or socket and can be removed without injury to either; and that it is durable and easily adjusted. The appliance is very simple and obviates many of the difficulties experienced in the protection of lamp sockets.

LAMP SOCKET PROTECTOR.

## Notes on Economy in Conductors in Systems of Distribution of Electrical Energy.*

In considering what economies it is possible to introduce into a system of conductors laid down for the distribution of electrical energy, one has at the outset to consider the relative merits of the different systems which have been proposed before investigating the best proportions to be given to different parts of the system fixed upon, and the proper current densities to be employed in them.

With regard to this first question, I do not propose to say more than a few words, or to deal with it in any but the most general way.

It is important to observe, in the first place, that the pressure to be used in houses for lighting by incandescence lamps has been practically limited to a maximum of 100 to 120 volts by the makers of the lamps, and that the pressure in buildings may not in any case exceed the 300 volts fixed by the Board of Trade. This consideration, while greatly hampering the system of simple parallel distribution, does not affect to any great extent the rival systems employing accumulators or secondary generators.

In his Cantor lectures before the Society of Arts in 1885, Prof. George Forbes gave a very interesting account of various systems and their sub-divisions; and he showed that, except for a very limited area of compact form requiring a large amount of light per unit of area, this system of simple parallel distribution is impracticable on account of the enormous expense of mains to carry the large currents necessitated by the use of so low a voltage. For a very small and compact area such as a block of buildings, it may be worth while to consider the applicability of this system, however, on account of its simplicity and the cheapness of the class of cable that may be employed.

No practical use of the series system for general station work has been made that I am aware of, though, of course, it is largely in use for outdoor lighting and transmission of power. It has the obvious advantage of requiring comparatively small conductors, but against that must be put the expenditure necessary for providing a complete system of automatic cut-outs for every lamp, motor, or other apparatus employed, and the difficulty of regulating with any reasonable degree of economy for the varying numbers of lamps alight on different circuits. The comparatively low efficiency of glow lamps for series lighting is also an important reason against the adoption of such a system.

The next system to which attention may be drawn is the series-parallel system, of which the modifications known as the three-wire, four-wire and similar systems are the most important. These are in general use both in England and abroad, and give for certain distributions of lamps a very good result indeed.

The degree of economy to be obtained with a three, four, or $n$ wire system over the simple parallel system depends on the certainty or otherwise with which you can rely on a continued balance of load between the different sections. This you would secure as far as possible by putting as many of each class of consumers in each section, and also, if practicable, by insisting upon the wiring of all buildings supplied being upon the same system as that of the mains, and the total load in every case distributed between the sections.

If you are sure that the load in any one section will never exceed that of any of the others by more than $m$ per cent. of the full load of a section, and the system is one of $n$ wires, then, if $E$ stands for the percentage reduction in amount of copper used from that necessary in an equivalent simple parallel system

$$E = 100 \left\{ 1 - \frac{200 + m\,(n-2)}{200\,(n-1)} \right\}$$

For example, let $m = 25$ and $n = 3$

then $$E = 43.8.$$

If, as in a case in which all the wiring is done upon the same system as that of the mains, we may take $m = 10$; and supposing $n = 4$, then

$$E = 63.3.$$

If in the same case we take $n = 5$,

$$E = 71.3.$$

In considering these systems it is necessary, in any practical case, to take into account the increased cost of labor in putting them down, and of the conduits or pipes in which they are inclosed. In connection with this, it is worthy of remark that with underground systems of mains —such as are likely to be in vogue in future—the cost of the actual cables may amount to less than 50 per cent. of the total cost of the cables laid.

With regard to systems employing accumulators or secondary generators, there is at once a great gain in the allowance of very much higher pressures in the mains. The cable is, however, very much more expensive, and the cost of the accumulators and their constant inefficiency must be taken into account in the one case, and in the other the cost of the converters and their inefficiency on light loads. In the case of accumulators it is necessary to distribute the energy from sub-stations upon some one of the low-tension systems, so that there is only a partial gain in respect to copper; and with converters, and especially those for alternating currents, it is well known that their cost per kilowatt output diminishes to a considerable extent as their size increases, so that with these also it may be and is advisable sometimes to employ sub-stations, so that the same remark will apply here.

I have now very briefly alluded to some of the conditions affecting the relative economies of the chief systems of distribution of electrical energy; and I have purposely refrained from examination of them in detail for the reason that every particular case will differ to some extent from any other, and in making a choice of the system to be employed to best meet its requirements, a special investigation should be made having regard to all the conditions involved.

Before taking up any problem such as those referred to in the abstract sent out to members, a word must be said as to the relation of price to size of cable. Bare wires, as you all know, are sold at so much a pound in general; stranded cables being a little more expensive than single wires, and wires smaller than No. 20 or 22 a little dearer than those above this size. Speaking generally, however, cables of bare wire of approximately the same cross-sectional area are sold at the same price per pound. Small insulated wires of a definite thickness of insulation, such as one of two layers of cotton or silk, are also often sold at so much a pound, but with these we have nothing at present to do, unless it be to remark that with such wires the insulation resistance necessarily decreases as the wire increases in size.

Insulated cables for use in any of the cases we have to consider are, I believe, invariably sold by length.

For a given class of insulation, and a given insulation resistance per mile, you would expect—seeing that for a given insulation the mass of the insulator is directly proportional to the mass of the copper insulated—that the prices should be very nearly proportional to the cross-sectional areas of the copper conductors. In practice this is very nearly so, for the price of a cable may be expressed by the equation

$$P = a + b\,A.$$

where $P$ = cost per mile in pounds.

$A$ = area of conductor in $\frac{1}{1000}$ of one square inch and where $a$ and $b$ are constants depending upon the class of insulation and the number of strands in the cable, with considerable accuracy with the cables of some of the best known makers.

Taking Silverton cables for example:

Class L.

| | | | |
|---|---|---|---|
| 7 strands | $P = 10.3 + 3.58\,A$ | within | 2.6 per cent. |
| 19 " | $P = 15.7 + 3.39\,A$ | " | 3.5 " |
| 37 " | $P = 22.5 + 3.32\,A$ | " | 0.7 " |

Class D.

| | | | |
|---|---|---|---|
| 7 strands | $P = 4.72 + 1.32\,A$ | " | 2.9 " |
| 19 " | $P = 7.22 + 1.27\,A$ | " | 4.6 " |
| 37 " | $P = 12.2 + 1.25\,A$ | " | 0.4 " |

The percentage errors given above are the maxima, and the average are from one-third to one-half these.

In a similar way the values of the constants for the other classes manufactured by the Silvertown Company may be tabulated, but I have not thought it necessary to do so here, more especially as I have not their most recent price-sheet by me.

With Fowler-Waring cables (lead covered) you would not expect this law to hold with the same degree of accuracy, as the thickness of lead is not proportional to the diameter of the cable. We have, however, for seven-stranded cables $P = 25.9 + 2.49\,A$, with a maximum error of 12½ per cent. and an average error of 4.8 per cent.

The cables of Messrs. Siemens are not manufactured upon the plan of having a given insulation resistance per mile for a given class of cable; the insulation resistance of their cables of a given class diminishes as the size of the cable increases. For example, for their classes L, M, and N, the insulation resistance per mile varies from 2,500 megohms for the smallest sizes to 300 megohms for the largest. You would not, then, expect to find the price of a cable proportional to its size, nor, in fact, is it actually nearly so.

With all cables, however, which are very nearly of the same size the price is, of course, very nearly proportional to the cross-sectional area of the copper, and over a narrow range the rule $P = a + b\,A$ still holds, the constants in any case being very easily determined byplotting a few points in the neighborhood of the size you want, and drawing the tangent to the curve (or the chord through points on either side of the size you estimate is about what you require) when the ordinate of the point of intersection of this tangent or chord with the axis of $y$ gives $a$, and $b$ is the trigonometrical tangent of the angle made by the line as drawn with the axis of $x$, it being supposed that prices are plotted as ordinates.

Now, in any case of central station work you can estimate from experience what is approximately the cross-sectional area of copper you want, so that we may take it that, for our purposes, the rule $P = a + b\,A$ holds universally. This may be regarded in the light that you pay a sum $a$ for the privilege of being allowed to buy the cable you require from the makers you are dealing with, and for the rest the price of this cable is directly proportional to its size.

*The most economical current density to employ for a constant and uniform current circuit working for a given number of hours per annum.*

Let $a$ = current in ampères;

$n$ = number of hours of working per annum;

$\rho$ = resistance of conductor of one square inch sectional area in ohms per mile;

$c$ = value of the Board of Trade unit in pence;

$d$ = sum of the rates of interest, depreciation and repairs on capital laid out in cable;

$x$ = sectional area of conductor required in $\frac{1}{1000}$ of one square inch;

$D$ = most economical current density to employ in ampères per square inch;

$P = a + b\,x$ as before;

then $$x = a\sqrt{\frac{n\,c\,\rho}{2.4\,b\,d}}$$

and $$D = 1{,}000\sqrt{\frac{2.4\,b\,d}{n\,c\,\rho}}$$

For copper conductors $\rho = 0.0425$, hence

$$x = 0.133\,a\sqrt{\frac{n\,c}{b\,d}}$$

and $$D = 7{,}513\sqrt{\frac{b\,d}{n\,c}}$$

For example, if we take Silvertown class L cable, and

$$c = 5$$

$$d = 13$$

we shall have the most economical current densities for different numbers of hours per annum given by the following table:

| $n$ | $D$. | | |
|---|---|---|---|
| | 7 strands. | 19 strands. | 37 strands. |
| 400 | 1,119 | 1,089 | 1,077 |
| 600 | 913 | 889 | 880 |
| 800 | 791 | 770 | 762 |
| 1,000 | 708 | 689 | 681 |
| 1,500 | 578 | 562 | 556 |
| 2,000 | 500 | 487 | 482 |
| 3,000 | 408 | 398 | 393 |

In this table $\rho$ has been taken as 0.0446, which is rather higher than it should be.

No account of the increased resistance of the conductor due to heating has been taken account of in the foregoing; but as the current density to employ in a given case is known approximately from previous experience after a little, an allowance can easily be made for the probable heating in the value of $\rho$ you decide to use.

### VARIABLE BUT UNIFORM CURRENT CIRCUITS.

If the current in a circuit is not a constant quantity—as in the case of series arc lighting—but variable throughout each day, and from day to day throughout the year, the value previously obtained for the most economical current density to employ refers to the square root of the mean square of the current for the year. In estimating or planning a system of mains it is more convenient to think about the most economical current density referred to the maximum current; that is to say, it is better to know that the greatest economy will be obtained in a given circuit if the current density, when the maximum current is flowing in it, is, say, 500 ampères per square inch, than to know that you obtain the most economical arrangement if the current density of the square root of the mean square of the current is, say, 300 ampères per square inch.

It is necessary, then, to consider what the ratio of the maximum current to the square root of the mean square of the current is likely to be in a given circuit; and the best way to arrive at this value is by examination of load diagrams obtained from similar districts.

When Prof. Forbes, in 1885, so strongly advocated the most thorough and careful working out of any system of mains to be laid down in order to obtain the most economical arrangement possible, electrical engineers were necessarily very much in the dark as to the data upon which to base their calculations. It is absolutely essential, in order to plan the most economical arrangement possible, to know beforehand what kind of load diagram you are likely to get. Fortunately, we have now a certain amount of experience to help us, but there is no doubt that in this respect the experience of the next ten years will be most valuable.

I have worked out one or two load diagrams for a single day in order to give an example. For this diagram, which was taken at Boston, the ratio of the maximum current to the square root of the mean square works out to 2.34, and for this second diagram, which was sent out by a town in the West of England in order that maintenance estimates might be prepared, the ratio is 3.57, and for this third diagram the ratio will be between 2.5 and 3.0.

With a slide-rule and planimeter it is, of course, a very easy matter to determine this ratio for any given load diagram. The value to be used, however, is that obtained from a complete set of diagrams taken at short intervals throughout the year, and in connection with this it may be mentioned that Dr. Gustav Rasch states that the value of this ratio (as obtained by observations at different central stations during one year, and taking the average value) is 3.41.

To take an example, let us suppose that the cost of a Board of Trade unit is 3 pence; that the sum of the rates of interest, depreciation, etc., is 15 per cent.; that current flows throughout the year in the circuit under consideration; that the ratio of the maximum current to the square root of the mean square is 3.2, and that the cable is 19-stranded Silvertown L. We have thus

$$b = 3.39$$

$$c = 3$$

$$d = 15$$

$$n = 8760$$

hence $$D = 3.2 \times 7{,}513\sqrt{\frac{3.39 \times 15}{8{,}760 \times 3}} = 1{,}058$$

*From the London *Electrical Engineer*. A paper read before the Old Students' Association, by Hamilton Kilgour, member.

In this case, then, the most economical current density is 1,058 ampéres to the square inch for the maximum current.

This determination of the most economical current density to employ for a given type of cable applies only to cases in which the current density is uniform throughout the cable under consideration. This is so, of course, in feeders, but not in the mains proper of a system of parallel distribution.

In the latter case the current flowing across any section of the conductor diminishes as the distance of the section under consideration increases from the feeding points. If we assume that in the mains between two pairs of feeding points the current taken off per yard is constant, we can determine a multiplier for the most economical current density obtained on the assumption that the current is uniform between the feeding points, which will give us what is really the most economical (maximum, or at a section very near the feeding points) current density to employ in the mains.

In the case we have supposed it is easy to see that this multiplier is $\sqrt{3}$ or 1.732. Now if we take, as before, 19-stranded Silvertown L cable, and make the same assumptions as to the cost of energy, etc., we find that the proper size of main to employ is that which gives us a current density of 1,832 ampères to the square inch at a section very close to the feeding points, and when the maximum current is flowing.

In the case of any other law according to which the current taken off per yard may vary, it is very easy by constructing, first, the curve of flow of current along the main, and secondly, the curve of the squares of the current, to deduce the proper multiplier by means of a planimeter and slide-rule.

The process of making the foregoing calculations for any particular case is certainly easy and very fairly rapid, but it is obvious that before attempting to design a set of mains for a particular district a thorough canvas should be made to ascertain its special requirements.

It should be remarked that the preceding investigation as to the effect of non-uniformity of current in the mains assumes that the load diagrams for the different buildings supplied between two pairs of feeding points are similar in character, a case which in general does not occur in practice, but for which allowance must be made either in the selection of an average load diagram or subsequently by special calculation.

I may end this portion of these notes by observing that though the current density arrived at may seem sometimes rather great, it occurs for such a very limited time that it is not likely to be harmful to the cables used.

TRANSMISSION OF POWER TO STATIONARY MOTORS.

The whole of the foregoing relates to general supply of energy from central stations, and the conclusions arrived at were all based upon the fact that in such work you have to maintain a definite pressure at the consumers, so that the current to be supplied is a fixed quantity.

As is very well known, Sir William Thomson first pointed out, in 1881, that in such cases the current density to be employed is independent of the length of conductor through which the energy is to be transmitted, and that the proper gauge to employ for a definite current is that which makes the value of the annual waste of energy per mile equal to the interest, depreciation, etc., on the capital laid out in conductor per mile.

There are, however, a large number of cases to which the above does not apply at all, and the transmission of power from a source where it is cheap to a distant point where it is valuable is one of the most important of these at present.

In a very important paper read by Professors Ayrton and Perry before the Society of Telegraph Engineers and Electricians, the authors gave, among other things, the solution of the following problem: What is the most economical current density to employ when a certain power $P$ has to be furnished at the end of $\frac{n}{2}$ miles, and when the pressure at the source has been fixed at $V$ volts.

If $C$ is the current in ampères, $r$ the resistance of the conductor per mile in ohms, $t$ a constant—depending on the number of hours of working per annum, the cost of the cable per pound of copper, the sum of the rates of interest, depreciation, and maintenance, and the value of a Board of Trade unit—and $F(C, r)$ the total waste of energy per mile reckoned in watts (*i. e.*, with the interest, depreciation, etc., on the cable expressed in watts as well as the actual waste of energy in the cable), we have

$$F(C, r) = C^2 r + \frac{t^2}{r} \qquad \text{(i)}$$

and further, $f(C, r) = P - C(V - n C r) = 0$ (ii)

From these two equations we have to determine $C$ and $r$, and hence the current density $D$, so that $F(C, r)$ is a minimum.

As you know the values of $C$ and $r$, which make $F(C, r)$ a minimum, are those obtained from the equations

$$\left(\frac{dF}{dC}\right) \cdot \left(\frac{df}{dr}\right) - \left(\frac{dF}{dr}\right) \cdot \left(\frac{df}{dC}\right) = 0 \qquad \text{(iii)}$$

and $f(C, r) = P - C(V - n C r) = 0$ (ii)

From these we obtain

$$C = \frac{P}{V} \frac{n t + \sqrt{(V^2 + n^2 t^2)}}{\sqrt{(V^2 + n^2 t^2)}} \qquad \text{(iv)}$$

and

$$D = 23.5 \frac{V t}{1 + \sqrt{(V^2 + n^2 t^2)}} \qquad \text{(v)}$$

the constant 23.5 being the conductivity of a copper conductor one mile long of one square inch sectional area.

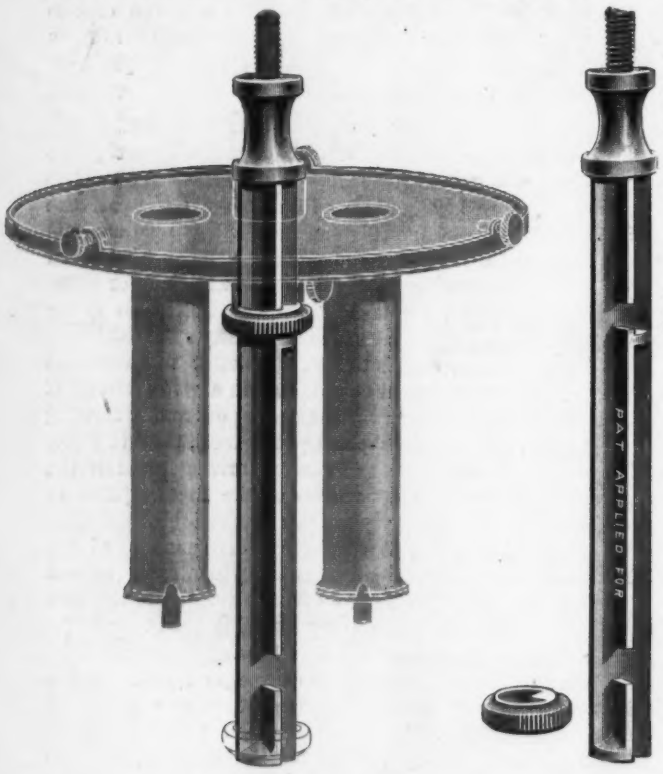
If we put $\frac{n t}{V} = \tan \varphi$

$$C = \frac{P}{V}(1 + \sin \varphi) \qquad \text{(vi)}$$

and

$$D = 23.5 \frac{V}{n} \left(\frac{\sin \varphi}{1 + \sin \varphi}\right) \qquad \text{(vii)}$$

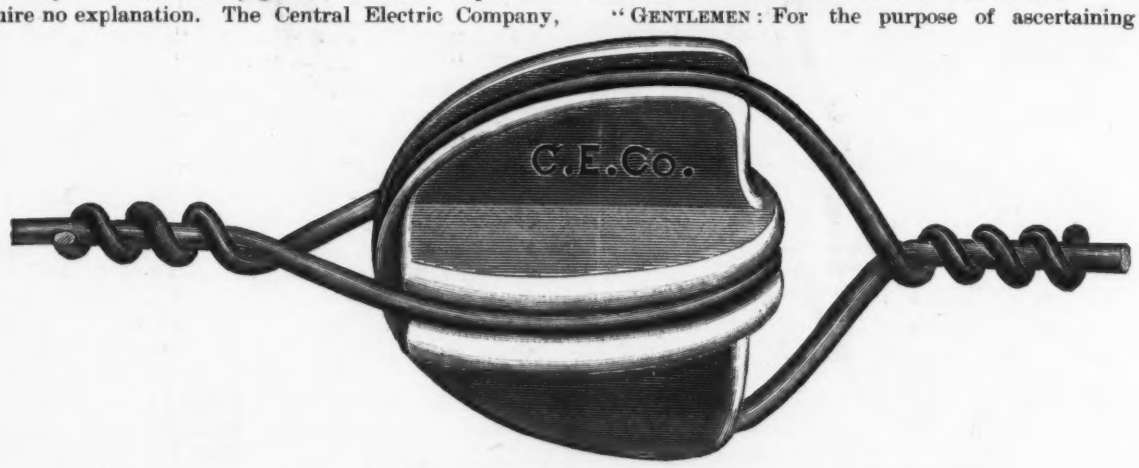
*(To be continued.)*




CUTTER'S GLOBE HOLDER.

## The Bain Break Insulator.

The new insulator illustrated on this page is made of one piece of porcelain, carefully glazed, and is so simple as to require no explanation. The Central Electric Company, of Chicago, is placing the device upon the market. The great strength and general adaptability claimed for it are sure to commend themselves to all practical construction men. This insulator will be found especially useful, also, for suspending arc lamps from iron cranes, insulating guy wires, and for insulating span wires in electric railroad work.




BAIN'S BREAK INSULATOR.

## Cutter's Globe Holder for Arc Lamps.

In trimming arc lamps much time is often lost either because the globe is fixed and in the way, or because the arrangement for slipping it down while the carbons are being renewed is imperfect. All this causes a loss of time in trimming the lamp, and does not tend to improve the good humor of the trimmer. As a simple substitute for this bothersome arrangement, George Cutter, of Chicago, has bought out the device illustrated on this page. As shown in the cut, a rod with a star-shaped cross-section is used instead of the tube, while the screw is replaced by a ring which is adapted to engage the rod at two points. When in use the globe holder proper rests on this ring, which is knurled so as to be readily turned with the fingers. A slight raising and turning of the ring allows it to drop to the end of the rod, thus lowering the globe out of the way. After the lamp is trimmed, the ring is raised again, and a quarter turn brings it back to its original position, where it supports the globe holder securely. To remove this entirely the ring is slipped down until opposite the lower notch in the rod, where both the ring and the globe holder can be taken off together. The globe can then be replaced and the holder slipped back and clamped in place in an instant.

## An Electric Cigar Lighter.

Since the dry battery has been made a commercial success all sorts of minor applications have appeared, its convenience and portability being so great that it can be employed in situations otherwise unavailable. The present cut shows the electric cigar lighter, which has been recently put upon the market by the Himmer & Anderson Dry Battery Company, of this city. It consists, as will be seen, of an ornamental wooden case furnished in front with sparking terminals over a little tray to catch drops of flying alcohol, and a pair of ordinary receptacles for the alcohol and the wire brushes. A couple of dry batteries

CIGAR LIGHTER.

and a spark coil located in the rear of the box supply the electricity. Like other devices of its class, it works admirably, and is a great convenience to the smoker, particularly in offices where the electric light is used, and consequently where matches are not as common as they might be.

## Electrical Exhibit at the World's Fair.

Director-General George R. Davis, of the World's Fair Commission, has sent a circular letter to all the manufacturers of electrical supplies and appliances, etc., in this country whose addresses he has been able to obtain. In drawing the plans for the building it is necessary to obtain as far as practicable an estimate of the space which will be required. It is urged, therefore, that those who propose to exhibit communicate at once with Mr. Davis' office as to the probable amount of space they will require, whether they have received one of the circulars or not. The letter sent out is as follows:

"GENTLEMEN: For the purpose of ascertaining approximately the amount of space that will be required for the electrical exhibits, and as it is contemplated to erect a building to be used exclusively for this purpose, I have the honor to request the following information: (1) Do you propose to make an exhibit? (2) If so, the approximate amount of space you will require. (3) The amount of steam, if any. A reply to above questions will not be considered as an application for space, but an estimate on which to base calculations for building. It is desirable that this information should be received within the next two weeks."

## The Mabbs Hydraulic Packing.

A demand has long existed for a hydraulic packing which would successfully fulfill the severe requirements

MABBS PACKING.

imposed by high pressure duty on steam pumps and hydraulic elevators. An article has been specially designed for such service by Mr. John Mabbs, an engineer of 40 years' experience. This packing is composed of raw hide or leather braided in either round or square section, as shown in the accompanying cuts. The material is so cured that it is thoroughly impregnated with grease, making extra lubrication unnecessary. The softness and pliability of the packing is remarkable, and the users of it say it gives excellent satisfaction.

### A Switchboard Plug.

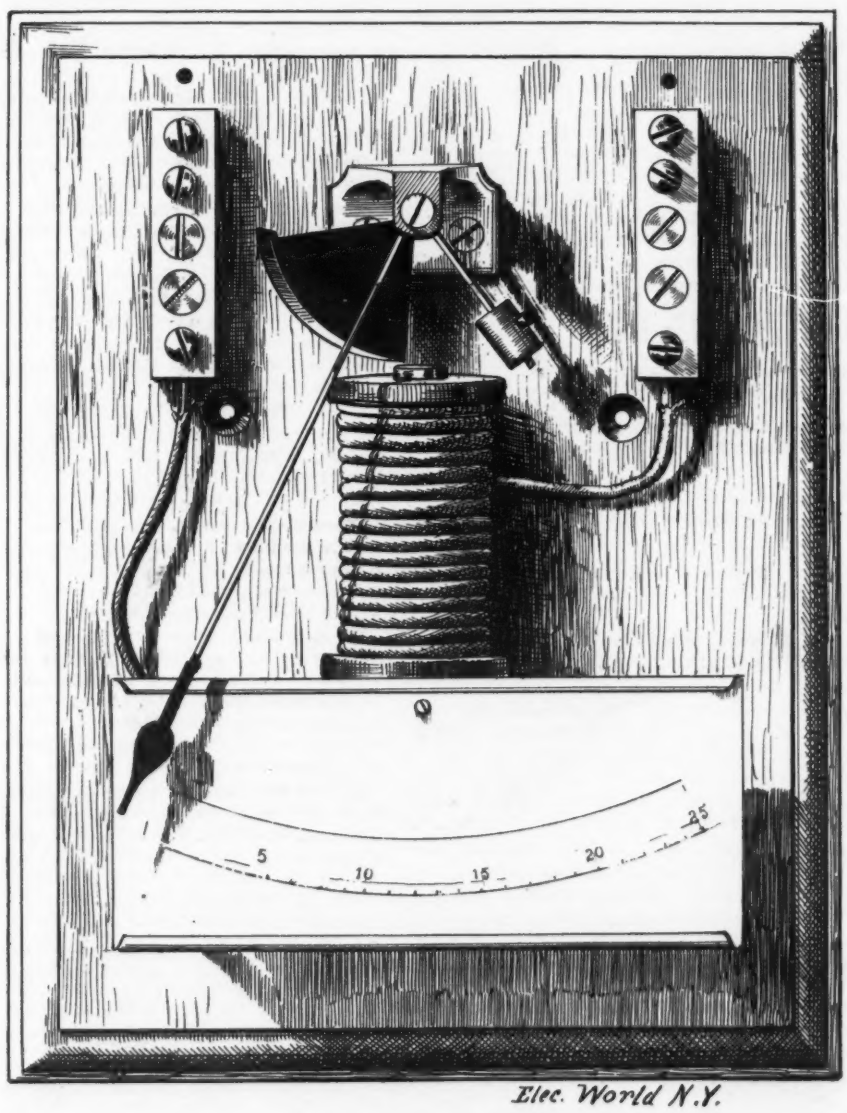
The little cut annexed shows a very neat spring plug for switchboard use. It is due to the ingenuity of Mr. Lungen, of Edwards & Co., of this city. The difficulty with the plug contacts is a certain tendency to wear irregularly, and produce in course of time badly fitting surfaces, which are hard to keep clean and give but indifferent contacts. In the present plug the rubbing surfaces are formed by a tube slit four times, and with the four segments slightly sprung outwards, so that on insertion into its proper hole a firm spring contact is obtained, and the slight rubbing during its insertion is sufficient to keep the surfaces

SPRING PLUG FOR SWITCHBOARD.

bright and clean. Such a form of plug necessarily accommodates itself even to worn holes, and ought to prove a great convenience where contacts have to be made so frequently that wearing becomes an important factor in the successful operation of a switchboard.

### A Simplified Ammeter.

A cheap and simple form of ammeter has long been desired as an adjunct to the operation of small plants, but, up to the present, the cost of apparatus had been greater than might be desired, and the advent of a much simplified




BERGMANN AMMETER.

form has been looked for with interest. The accompanying illustration shows the new ammeter just produced by the Bergmann Electric Company, of this city. As will be seen, it has the general form of the customary Bergmann instruments to be found in nearly all Edison plants. The construction of this instrument, however, is peculiarly simple. The actuating power is supplied by a straight solenoid with a small iron core, and the armature which controls the needle is in the form of a sector of brass furnished with a rim of thin sheet iron varying in width; as the current increases the wider parts of this rim are drawn into the field and the needle is swung over. The form shown is designed for 25 ampères, and is sufficiently sensitive to serve very readily as a lamp counter; as much as half an ampère is distinctly shown. For many small isolated plants, storage battery installations and the like, this simple and cheap ammeter will fill a long felt want, and the reputation of the company which furnishes it is at least a guarantee of careful workmanship. Of course it is not intended for delicate measurements, but has all the accuracy necessary for a station instrument, and can be manufactured so cheaply that its use will be practicable under almost any circumstances.

### December Meeting of the American Institute of Electrical Engineers.

The regular monthly meeting of the American Institute of Electrical Engineers was held at the rooms of the Institute on Dec. 9, and the papers read were of great interest to the members. The first business of the evening was a report of the committee on the "Practical Unit of Self-Induction," presented by Dr. Geyer in the absence of Prof. Crocker, the chairman. The substance of this report was to favor the adoption of the present value of the earth quadrant for the henry, on the ground that, although so large a value will necessarily result in many inconvenient fractions, the unity of the system of practical units would be infringed by making the henry a sub-multiple of the earth quadrant. Discussion of this report was deferred until the next meeting.

Mr. A. E. Kennelly then read a paper on "Inductance and Its Proposed Unit, the Henry," reading it only by abstract, as the printed copies were already in the hands of many of the members, and the hour was growing late. Mr. Emile Berliner then gave an elaborate description and practical demonstration of his perfected gramophone; demonstrating both the process of recording the voice and reproducing the etched records. A number of musical selections from gramophone records were given, showing the capabilities of the instrument in reproducing the tones of various instruments. The gramophone, giving as it does a permanent metallic record sheet, is quite unique among speech-recording instruments, and its performance was listened to with the greatest interest. The volume of sound obtained was sufficient to enable the music to be heard with the greatest ease in the most remote parts of the hall, and some of the selections gave the instrumental tones with great accuracy. Altogether the evening was a most interesting and entertaining one, and was signalized by an unusually large attendance, many ladies being present in addition to the regular membership.

### The Electrical Stock Market.

The market has been very dull during the past week. The coming holidays have already commenced to show their effect. Fewer shares of stock were disposed of than for several months past. The situation may be considered better than last week, although stocks have not risen to any great extent. Prices have been firm, and yet there have been many commercial failures and a few banks have been compelled to shut their doors.

The weekly bank statement was satisfactory, showing over $4,000,000 increase in the bank reserve. It is safe to predict an easy money market, as affairs are assuming steadiness and as so much money will be afloat with the first of the year in accumulated dividends. It is estimated that about $100,000,000 will be released in dividends on stocks of corporations, etc.

The stock market has had a tendency generally to weaken before the holidays, and to rise afterwards. So we may therefore expect little improvement during the coming week, but may confidently look for a rise a little later on, unless all signs fail.

The tendency of some of the Western railroads to come together and establish rates which will become standard and prevent ruinous competition has been demonstrated for some time, and the meeting held last Monday is likely to produce substantial benefit.

The advantage of investment in securities representing commercial business outside of railroad shares is shown to the writer more plainly than ever. The recent decline in railroad stocks was due largely to manipulation, and those properties went down like a house of cards before the expert manipulation of Mr. Gould and his co-laborers of the bear contingency. When prices were satisfactorily low then shares were bought in and the market afterwards forced upward. The basis of earnings of the roads was not studied, but the stocks were played upon from every conceivable source to push them down.

England has found that its best investments in this country have been in commercial business and not in railroad shares, and the greatest financial writers in England favor the deduction drawn above so far as their investments in America are concerned.

Railroad corporations as a general thing are in the hands of a few men, and the company is run largely for the aggrandizement of these few, and enormous salaries are charged up for the officers of the concern. Companies representing commercial business are generally run with much more economy. If such is not the case, then the stock readily goes to pieces and the company along with it. Expert manipulation such as takes place in the railroad market is not demonstrated to any great extent in corporation stocks, of which electrical securities form an important part.

The list of electrical stocks given below in the weekly report generally represents dividend-paying properties, and when these stocks make an abnormal drop there is some good reason for it. Some of these stocks are affected by the general stock market, undoubtedly, by being closely allied with it, but they are very ready to turn quickly after reaction and find their normal position, and much more rapidly than railroad shares.

A word in regard to the financial condition of the general electrical construction business, particularly that part relating to wiring and installation of electric plants, will perhaps not be amiss at this time. These concerns, particularly those doing a wiring business, have not been very successful of late. It is found that competition is so great with the electric light companies that they have organized their own wiring concerns, and in many instances have been known to do wiring for nothing, provided they might supply the current thereafter. Seemingly it would be just as sensible for gas companies to go into the gas fitting business as for electric light companies to pursue the course they are following. They could give out their wiring contract and have the work done perhaps more economically than they can do it themselves, but for some reason there seems to be a desire to cut the construction business out of the field. This is an injustice which works no good to the electric light companies and does great harm to persons engaged in the construction business.

A complication has arisen between the Automatic Phonograph Exhibition Company, which controls the nickle-in-the-slot phonograph, and the parent organization, the North American Phonograph Company. The former company has secured an injunction against the latter preventing them from selling phonographs. The hearing is to take place in the early part of January.

A gentleman who is thoroughly conversant with the affairs of the North American Company stated that the company proposed to fight the injunction to the end, and that no compromise would be listened to which prevented the sale of machines. He said that all sub-companies under license of the parent organization were under agreement to change the method from renting to selling phonographs, if it was the opinion of the North American Phonograph Company that the business would be bettered by so doing. This change was to take place the 1st of January next, and the company proposed to sell phonographs. The position is unfortunate, he thought, for the present, because it prevented the North American Phonograph Company from disposing of a large number of the old phonographs and graphophones on hand, and that the injunction meant delay, which would be injurious all around, but that the result in the end would be thoroughly satisfactory to all holders of North American Phonograph stock. It was simply a question whether the parent organization was to run its business on the lines originally proposed, and whether it had entered into any contract with the Automatic Phonograph Exhibition Company which would prevent it from so doing. The informant was sure that the North American Phonograph Company had not embarrassed itself by entering into any contract which would restrict its business, and proposed to proceed on that basis.

The position of the Automatic Phonograph Company has not yet been learned.

The phonograph business is increasing, and it is decidedly to be regretted that anything should occur to hinder it. The principle of renting phonographs, regardless of any legal questions now arising, has been fought against from the first by many persons prominent in the direction of the business. Mr. Edison proposed originally to sell machines. There seems to be no more reason for renting the phonograph than renting the typewriter to which it is allied. Such a course would have been detrimental to the vast business built up by the typewriter companies.

The Edison General Electric Company announces the payment of the fifth quarterly dividend of two per cent. on its stock payable Feb. 2, 1891.

A special meeting of the stockholders of the above named company will be held Jan. 19 for the purpose of voting on a proposed increase of its capital stock from $12,000,000 to 15,000,000. There is little doubt about the accomplishment of this proposition, as the control of the stock is in the hands of comparatively few and the matter has been practically decided upon by them. Edison stock has been very steady during the week and closed at 84, which is three points above last week's closing figures.

Thomson-Houston has had rather an active market and also closed above last week's report, making a gain of 2¼ points. The "Preferred" also rose ¼ point.

American Bell stock has remained about where it was, making a net gain of one point.

Closing quotations of electric stocks, from F. Z. Maguire & Co., electrical securities, 18 Wall street, N. Y., Satur-

day, Dec. 20, 1890. New York, Boston and Washington stock exchanges. Pittsburgh closing Dec. 19:

| Name of Stock. | Par. | Capitalization. | Bid. | Ask'd. |
|---|---|---|---|---|
| **NEW YORK.** | | | | |
| Western Union Telegraph Co | 100 | 86,200,000 | 75 | 75¼ |
| American Telegraph & Cable | 100 | 14,000,000 | 83 | 85 |
| Central and South American | 100 | 5,000,000 | .... | .... |
| Mexican | 100 | 2,000,000 | .... | .... |
| Commercial Cable Co | 100 | 7,716,000 | .... | .... |
| Postal Telegraph Cable | 100 | 5,000,000 | 39 | 41 |
| Edison General Electric Co | 100 | 9,503,500 | 84 | 85 |
| " " Deferred | 100 | 2,496,500 | .... | .... |
| Consolidated Electric Light | 100 | 1,922,400 | .... | .... |
| Edison Electric Illuminating Co | 100 | 2,567,800 | 70 | .... |
| United States Electric Light | 100 | 1,500,000 | 30 | .... |
| North American Phonograph | 100 | 6,200,000 | .... | 35 |
| **BOSTON.** | | | | |
| Thomson-Houston Electric Co | 25 | 6,000,000 | 42 | 42½ |
| " " preferred | 25 | 4,000,000 | 26 | 26¼ |
| " " Series C | 10 | 400,000 | ... | 12 |
| " " Series D | 10 | 120,000 | 5¾ | 6 |
| " International Co | 100 | 350,000 | .... | .... |
| Thomson Welding Co | 100 | 1,000,000 | .... | 200 |
| " European Welding Co | 100 | 1,500,000 | .... | 50 |
| Ft. Wayne Electric Co | 25 | 4,000,000 | 11 | 11½ |
| Telephone: | | | | |
| American Bell | 100 | 12,500,000 | 211 | 212 |
| Erie | 100 | 4,800,000 | 46 | 47 |
| New England | 100 | 10,304,600 | 48½ | .... |
| Mexican | 10 | 1,280,000 | 70c. | 80c. |
| Tropical American | 10 | 400,000 | .... | 1¼ |
| **MISCELLANEOUS.** | | | | |
| Edison Phonograph Doll | 10 | 1,000,000 | .... | 2 |
| **WASHINGTON.** | | | | |
| Pennsylvania Telephone | 50 | 750,000 | 25 | 33 |
| Chesapeake & Potomac | 100 | 2,650,000 | ... | 72 |
| American Graphophone | 10 | 600,000 | 11 | 12 |
| United States Electric Light (Washington) | 100 | 300,000 | 135 | 145 |
| Eckington and Soldiers' Home Electric Ry | 50 | 352,000 | 52 | 56 |
| Georgetown and Tennallytown | 50 | 200,000 | 45 | 55 |
| **PITTSBURGH.** | | | | |
| Westinghouse Electric Mfg. Co | 50 | 5,000,000 | 12¾ | 13¼ |

Col. S. G. Lynch, broker, of 153 Monroe street, Chicago, furnishes quotations on telephone stocks as follows:

| | | | |
|---|---|---|---|
| Chicago | $298@$300 | Cumberland | $ 59@ $60 |
| Central Union | 57@ 58 | Wisconsin | 118@ 120 |
| Michigan | 91@ 93 | Bell of Missouri | 155@ 160 |
| Great Southern | 32@ 35 | Iowa Union | 20@ 21 |
| Colorado | 38@ 40 | Missouri and Kansas | 55@ 57 |
| Rocky Mountain Bell | 40@ 45 | | |

**ELECTRIC LIGHT STOCKS.**

| | | | |
|---|---|---|---|
| Chicago Arc Light and Power | $85@$90 | Chicago Edison Co | $128@$130 |

# Special Correspondence.

## NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, Dec. 22, 1890.

**Wants Permission to Use Electricity.**—Mr. William Richardson, president of the Atlantic Avenue Railroad Company, of Brooklyn, has petitioned the Aldermen to allow the use of electric power by his company in operating its cars. The matter was referred to the Railroad Committee.

**New York Electric Club.**—The limit of membership of the Club has been increased from 750 to 1,000, and the classification changed from resident and non-resident to active and associate respectively. Heretofore the initiation fee of resident members has been $50 and annual dues $50, non-resident members paying an initiation fee of $25 and annual dues of $30. Under the new classification the initiation fee of active members has been reduced from $50 to $40, and annual dues reduced from $50 to $40, and for associate members the initiation fee of $25 reduced to $20, and annual dues to $20. All reference to the residence of members is eliminated from the amended by-laws.

**Evening Lectures on Electricity.**—The following course of evening lectures on practical electricity, fully illustrated by experiments, will be given at Columbia College, by Francis B. Crocker, E. M., and Michael Pupin, Ph. D., the instructors in electrical engineering, on successive Thursdays, at 8 o'clock, commencing Jan. 15, 1891: (1) General Principles of Electricity, showing principal ways of producing it and effects produced by it; (2) Electro-magnetism; (3) Electrical Units and ways of measuring electricity; (4) Dynamo-electric Machines; (5) Electric Motors and transmission of power; (6) Electric Lamps; (7) Alternating Current Electricity; (8) The Telegraph; (9) The Telephone; (10) Storage Batteries. The lectures are intended to give a reasonably intelligent idea to professional and business men of the most important practical applications of electricity. The fee for the course has been fixed at $10, payable in advance. Persons desiring to avail themselves of this opportunity must register their names in the president's office on or before Jan. 10, 1891, and pay the fee at the time of registration.

**Mr. William J. Hammer,** consulting and constructing electrical engineer, of this city, has issued for the information of his friends and patrons a very handsome pamphlet which contains well executed illustrations of work with which Mr. Hammer has been intimately connected. Among these may be mentioned the Edison display at the Paris Exposition, the Edison exhibit at the Cincinnati Exposition in 1887; the Edison display at the International Electrical Exhibition at Philadelphia, and various other electrical exhibits of which Mr. Hammer has had charge. Mr. Hammer has had a varied experience in all classes of electric work in Germany, France, England and America, covering the past 12 years, and has become well known among electricians in this country and Europe. The pamphlet contains some excellent letters of recommendation given in fac simile from Mr. Edison, Prof. Elihu Thomson, Mr. F. J. Sprague, Mr. E. H. Johnson, and others. An illustration is also given of Mr. Hammer's historical collection of incandescent lamps. Mr. Hammer's record in the various classes of work as set forth in this little pamphlet is certainly an admirable one and the reputation which he has already attained is one of which any electrician might well be proud.

**The Interior Conduit and Insulation Company,** at Thirty-fourth street below Tenth avenue, this city, has in the "treating" department a number of upright boilers 30 feet high and several feet in diameter, extended through two floors. The third floor is used for the cranes, which raise and lower the iron cages or crates containing the tubes or conduits, which are let down into the boilers which contain the solution for insulating, waterproofing and also fireproofing the paper tubes. The rates will hold nearly 2,000 feet of the paper tubes in 10-foot lengths. After going through a special process there the tubes are taken to the other departments, where a mandrel is passed through each tube; this process is hardly necessary as the tubes after being treated in the boilers are left clear. This company is using two new buildings, one 26 × 87, six stories high, and one 35 × 45, four stories high, and is completing the use of one large building 50 × 75, with entrance on 35th street. The machines used in making the tubes are the most ingenious pieces of mechanism. They automatically form the tube by running the special paper diagonally over a mandrel, each layer in an opposite direction overlapping the seams of each layer of paper. A different number of layers can be used according to the use to which the tubes are to be applied, but there is a standard number of layers for all interior tubes. These machines form the tubes and automatically cut them off ten feet in length. In other departments the elbows, junction boxes, sleeves for the underground system, etc., are formed. The underground system laid in Minneapolis last summer, is giving entire satisfaction.

**American Institute of Electrical Engineers.**—At the regular monthly meeting of the council, held Dec. 16, the following associate members were elected: P. H. Alexander, president of the firm of Alexander, Barney & Chapin, 20 Cortlandt street, New York City; Charles E. Dressler, maker of scientific and electrical apparatus, College of the City of New York, 17 Lexington avenue, New York City; E. L. French, draughtsman, Mather Electric Company, Manchester, Conn.; Arthur Handley, electrical engineer, Electrical Engineering Company of Ireland, L't'd, 61 Dawson street, Dublin, Ireland; George Mayer, mechanical draughtsman, Edison General Electric Company, 68 Broad Street, New York City; Wm. F. Murphy, electrician, Spartanburg Electric Light and Power Company, Spartanburg, S. C.; F. B. H. Paine, consulting electrical engineer, Chas. Pain & Sons, 71 Broadway, New York City; Chas. Lane Poor, tutor, College of the City of New York, 17 Lexington avenue, New York City; Samuel Sheldon, A. M. Ph. D., professor of physics and electrical engineering, Polytechnic Institute, Brooklyn, N. Y.; Wilfred J. Spruson, member of the firm of Hepburn & Spruson, consulting engineers and electricians, 169 King street, Sydney, Australia; M. C. Sullivan, with the *Electrical Engineer*, 150 Broadway, New York City; John Waring, consulting electrician, The Perkins Electric Lamp Company, Manchester, Conn. At the same meeting the following associate members were transferred to full membership, their applications having been approved by the board of examiners at its meeting held Dec. 3: Harold Binney, assistant in the practice of patent law, 245 Broadway, New York City; William Herbert Donner, designing draughtsman and electrical engineer, Thomson-Houston Electric Company, Lynn, Mass.; Reginald A. Fessenden, assistant electrician, U. S. Electric Light Company, Newark, N. J.; Dr. Cary T. Hutchinson, electrical engineer, 56 West 25th street, New York City; Dr. Frederic A. C. Perrine, superintendent insulated wire department Roebling's Company, Trenton, N. J.; Herbert Laws Webb, assistant electrician Metropolitan Telephone and Telegraph Company, New York City; Townsend Wolcott, consulting electrician, 819 Green avenue, Brooklyn. The total membership of the institute is now 500. W. T. H

## NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 8, Cook Building, cor. Franklin and Congress Sts.
BOSTON, Dec. 20, 1890.

**Fred. H. Whipple & Company** will open an office in Boston Jan. 1 at 624 Atlantic avenue. Mr. W. J. Pilicy will represent them in this territory.

**Tripp Truck.**—One of the new Tripp 28-foot cars is now running on the Oak Square, Brighton and Tremont House division of the West End Railway.

**The New England Printing Telegraph Company** is now working its own wires from Boston to Providence, Woonsocket and Pawtucket.

**The Consolidated Electric Manufacturing Company** has installed a 10-light arc plant of the American system for the Lynn Foundry Company, Lynn, Mass.

**The Eastern Electric Supply and Construction Company,** Boston, has now in stock a full supply of Alexander, Barney & Chapin's specialties, including the celebrated Fibrone goods.

**The Standard Electric Company of Vermont** has installed a 50-light plant at Beaver Mills, Keene, N. H., and a 200-light plant for the East Shore Terminal Company, Charleston, S. C.

**The Robinson Radial Car Company** has recently sent several trucks equipped with motors to Paris, France, these having been ordered by cable. They are to be used in connection with a storage battery system.

**The Pope Manufacturing Company,** of Boston, manufacturers of the Columbia Bicycle and World Typewriter, has just issued a new desk calendar for the year 1891, with removable leaves and plenty of space for memoranda, making it a desirable article for every business man's desk.

**Two Big Copper Castings.**—The Lynn (Mass.) Brass Foundry has just made for the Thomson Electric Welding Company two copper castings of very large size. They weigh 1,500 pounds, and are to be used in the welding machines being erected for the United States Government for the navy yards.

**Salem, Mass.**—The board of aldermen has refused permission to the Naumkeag Street Railroad Company to lay a double track to the Willows. Also, permission was refused to the Essex Electric to extend its tracks to the Willows. Leave to withdraw was voted to the Naumkeag road on a petition for leave to double track Essex street.

**The Pettingell-Andrews Company,** which is engaged in the electric light and railway supply business, has been put in the unlisted department of the Boston Stock Exchange. The capital, $200,000, is in 8,000 shares of $25 par value. The officers are: F. E. Pettingell, president; D. A. Andrews, Jr., vice-president; D. A. Andrews, treasurer; C. B. Price, secretary, and these, with Ambrose Eastman, are the directors.

**Electric Club Election.**—The Boston Electric Club, at its annual meeting, elected officers as follows: President, Captain Eugene Griffin; vice-presidents, C. J. H. Woodbury, C. L. Edgar; treasurer, F. J. Boynton; secretary, R. F. Ross; historian, Geo. W. Mansfield. A crayon portrait of the retiring president, Henry B. Cram, was presented to the club. A series of papers on electrical subjects, to be issued under the auspices of the club, is contemplated for this winter.

**Mr. George W. Mansfield,** of the Thomson-Houston Electric Railway Company, gave a lecture on electricity last Wednesday evening before the Pawtucket (R. I.) Business Men's Association, including a brief résumé of the history of electricity and some of the beautiful experiments with the alternating current recently shown by Professor Thomson before the members of the Boston Electric Club. The address was most entertaining and instructive and was enjoyed by the business men.

**Manchester, Conn.**—The directors of the Mather Electric Company have decided to make application to the Legislature this winter for a charter under which they can organize a separate company for the purpose of lighting the streets of Manchester, furnishing electric power and, if deemed advisable, building and operating a tram-way between Manchester and South Manchester. The incorporators of the new company are N. T. Pulsifer, M. S. Chapman, H. G. Cheney and Robert Cheney.

**Marlboro, Mass.**—It is reported that the Washburn & Moen Wire Company, of Worcester, is considering building a branch of its plant at this place. Recently several of the officials of this company visited Marlboro, and looked over the place with the hope of securing a suitable site for a building. Nothing definite was done, and here the matter has dropped, at least for a while. The residents are anxious to secure the industry, and in all probability steps will be taken to induce the concern to locate there.

**R. T. White** is rapidly coming to the front with his street railway material. Among the many strong testimonials recently received was one from Superintendent Henderson, of the Newton Street Railway, in which he says that "when laying track in Newton we gave your Daisy chair a severe test by running a 17-ton steam roller over our roadbed, first filling it in with ten inches of crushed rock; we found no evidence of failure to hold this immense weight." Mr. White's patents on Eureka construction that were in interference have been issued.

**Inspector of Wires Flanders** has made the following changes: C. A. George, promoted from assistant superintendent of fire alarm telegraph to assistant inspector of wires; W. H. Godfrey, promoted from foreman of construction to deputy inspector and assigned to the fire alarm branch; J. L. Gethins, promoted from assistant operator to operator in the fire alarm branch; Richard Donahue, from batteryman to assistant operator in the fire alarm branch; H. W. Cherrington, promoted from repairs to foreman of construction, and assigned to the fire alarm branch. It is estimated that there are over 5,000 miles of overhead wires in this city, 525 miles of which belong to the fire alarm department. Superintendent Flanders will at once begin the work of removal of all dead wires. The fire alarm system of Boston was the joint invention of Dr. W. F. Channing and Prof. Moses G. Farmer, both of whom are now living. The system was put in operation April 28, 1852, and was probably the first electric fire alarm system in the world. L. H. H.

## PHILADELPHIA NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
31 CITY BUILDING, PHILADELPHIA, Dec. 20, 1890.

**The de Kosenko & Hetherington Manufacturing Company** is moving to its new quarters in the Times Annex Building on Sansom street.

**Mr. J. W. Parker** is ending up the year with a brisk business. He sold last week to Messrs. Hansom Bros., of 704 Sansom street, a 10 h. p. C. & C. Motor, and five and three h. p. motors to Mr. H. K. Reber, of Reading, Pa., besides several smaller machines.

**The Star Electric Company** has greatly increased its facilities for the manufacture of its specialties by additional room and several new machines. The company now employs over 35 people, and is turning out at the rate of 1,500 switches and 1,000 ceiling cut-outs per day.

**Vallee Bros & Co.** have sold a 10 h. p. Connecticut motor to the Market Street National Bank to operate pumps for a hydraulic elevator. This company is the agent for Philadelphia and vicinity for the well-known "Solar" carbons and the New England switch manufactured by O. S. Platt, of Bridgeport, Conn.

**Messrs. Queen & Co.,** of this city, recently made and sold to the Central Passenger Railroad Company, of Louisville, Ky., an ammeter reading to 1,300 ampères. This company is doing an extensive business with its magnetic vane, supplying the Edison. Brush, Mather and several electrical companies.

**R. L. Cohen & Co.,** 903 Market street, Camden, N. J., are making a slow-speed motor which is meeting with much favor. They have quite a number in operation in this city which are said to give perfect satisfaction. Among the latest installations is a 125 light incandescent plant for Messrs. Edward Darby and Sons, of 233 Arch street. The armature of this machine makes 750 revolutions per minute.

**A New Electric Railway.**—Application is about to be made for a charter for the Reading, Shillington & Mornsville Electric Railroad. It will be five miles in length, and will connect Mornville, a flourishing manufacturing town of 1,200 inhabitants, with the county seat, passing also through Oakland, Shillington and Hendelton, all growing places. The capital stock is $50,000, divided into 1,000 shares of $50 each.

**Lectures on Electricity.**—Mr. Hermann S. Hering, professor of applied electricity in the Central Manual Training School, Philadelphia, Pa., is delivering before the educational department of the Y. M. C. A. of that city a course of 25 lessons in electricity covering the measurement, generation, and the application of electricity. The lessons are of an elementary character and thoroughly practical, and are illustrated by experimental demonstrations whenever possible.

**Messrs. Walker & Kepler** made the following installations last week: The Moore & White Paper Company, Fifteenth street and Lehigh avenue, one 135-light dynamo; Wm. Simpson, Sons & Company, 128 Chestnut street, one 50-light dynamo with Otto gas engine; Southwark Foundry and Machine Company, one No. 20 Edison dynamo to drive stationary motors; John Wanamaker, Thirteenth and Chestnut streets, 500-light dynamo; John Stewart & Son, Frankford Junction, one 135-light dynamo. W. F. H.

## WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 THE ROOKERY, CHICAGO, Dec. 20, 1890.

**Mr. G. L. Patterson,** representing Stanley & Hall, has been a welcome visitor in Chicago for the past two days.

**Marquette, Mich.**—The Lake Superior Electrical Construction and Supply Company has filed articles of incorporation. The capital stock is $200,000.

**The Interior Conduit & Insulation Company** of New York has appointed Mr. H. M. Underwood as its Western agent, with headquarters in the Owings Building.

**Mr. H. Ward Leonard,** general manager of the lighting department on the Edison General Electric Company, spent a few days in Chicago recently.

**Mr. Frederick Sargeant** has accepted the western agency of the McIntosh & Seymour Engine Company, of Auburn, N. Y. With so energetic an agent for so excellent an engine, its general popularity is assured.

**Streator, Ill.**—The Streator Gas and Light Company has recently erected a new building and has consolidated the gas and

electric plant. The company has also installed one 1,200-light alternator and three 60-light arc machines.

**Mr. J. P. Wilson,** late superintendent of the Great Western Power Construction Company, has associated himself with Mr. W. B. Pearson, 403 Home Insurance Building, Chicago. Mr. Wilson will hereafter devote his energy and skill to the advancement of the interests of the Ball Engine Company.

**Mr. C. A. Ross,** manager of the Kansas City office of the Thomson-Houston Electric Company, reports the sale of two 25-light arc machines, and a 650-light alternator to parties at Lamar, Mo., a 500-light alternator at Pierce City, Mo., and a 650-light alternator at Brookfield, Mo.

**Mr. Chas. T. Jaeger,** late of the firm of H. Jaeger & Company, Brooklyn, N. Y., has established a fully equipped glass blowing factory at 200 Kinzie street, Chicago. Mr. Jaeger will give special attention to the manufacture of his improved vacuum pump, designed especially for incandescent lamp manufacturers' use, and to the filling of orders for all kinds of fine and difficult experimental work.

**Capt. C. F. Dunderdale,** the consulting engineer of the Gray Current Motor Company, of Elgin, Ill., reports that the company has secured the large water power of the Rock River, at Oregon, Ill., and will at an early date increase the height of the present dam there and erect a large power station, equipped with the Gray current motors, electric generators and all the necessary plant sufficient to distribute some 3,000 h. p. in the form of electrical energy, by means of cables, to manufacturing establishments located in the town, so that it can be utilized to operate electric motors, street railways, etc.

**New Officers.**—The Great Western Electric Supply Company, of Chicago, has made some changes in the management. The present officials are: Mr. E. R. Gilman, president; Mr. H. K. Gilman, vice-president and general manager, and Mr. T. C. Turlay, treasurer. Mr. H. K. Gilman will have personal charge of the Chicago office, assisted by Mr. G. M. Angier, formerly of the Thomson-Houston Company, who now has charge of the railway department. Mr. E. R. Crolius retains his position as manager of the house goods and fixture department. The latter gentleman has been with the house since its opening, and has made many friends among the Chicago customers. The other gentlemen are new to the customers of the company, but hope to make many friends.

**Brilliant Window Displays.**—The Electrical Supply Company is giving nightly exhibitions of beautiful effects obtained by the use of Geissler tubes. The large show windows are draped at the back and sides with black cloth against which the light effects show to perfection. In one window is placed a large five-pointed star made of mirror reflectors, in front of each division being placed a small coiled tube showing changing colors. In the other window at the top are the letters "E.S.C." made of tubes giving variously colored lights, the letters being illuminated in succession. Underneath this is a revolving wheel operated by a motor, the spokes and rim being formed of tubes giving changing colors. Below this and partially hidden in the folds of the cloth are several large tubes, with many bulbs and coils, giving an effect at once brilliant and beautiful.

**Interior Conduit Test.**—The efficiency and usefulness of the conduits manufactured by the Interior Conduit and Insulation Company were clearly demonstrated by a test made in the dynamo room of the Chicago Edison Company this afternoon. A temporary switchboard was erected at one end of the room, upon which were run the circuits from the dynamo. A two-wire circuit was used. In the first test a common non-fireproof tube, inclosing a single No. 18 B. W. G. paraffine-covered wire was used, and a current of 97 ampères was passed through it. Inside of 30 seconds the wire was red hot and smoking badly, and shortly after the wire was melted. The tube was unharmed. In the second test two No. 18 paraffine insulated wires in multiple arc were placed inside of common non-fireproof tubes. These were attached to one pole, and attached to the other pole were two similar wires incased in ordinary wood molding. In a little over one minute the molding was burned, the wires melting in five minutes. In the third test the same conditions as before existed, except that rubber-covered wire was used. The molding took fire in seven and one-half minutes from the time the current was turned on. In the fourth test a rubber-covered wire was attached to one pole, and was left exposed, a similar wire being attached in multiple, but placed inside of the tube. Under a heavy overload the insulation was burned off in 10 seconds. In the fifth test two bare wires were placed two and one-half inches apart upon a piece of smooth board. These were short-circuited by moisture. The fusible plug was not blown, but the molding was set on fire. In the sixth test two bare wires were placed close together on a smooth board and a short circuit formed. The plug was blown immediately, showing advantage of placing wires close together. The current was 97.2 ampères 126¾ volts. No. 18 B. W. G. wire was used throughout. There were present Forée Bain; Chief Swenie, of City Fire Department; J. P. Barrett; C. C. Haskins, city inspector; Superintendent Church, Secretary Gorton, Superintendent of Construction Goehrts, of Edison Company, and Messrs. Affeld, T. S. Cunningham, Webster and Gen. Drew, of the Board of Fire Underwriters; Chief Smith, of the National Board of Underwriters of New York, and C. B. Stevens, Denver, Col.

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MINNEAPOLIS, Dec. 19, 1890.

**Louis Schultz,** a local electrician, died of pneumonia last Tuesday.

**The Minneapolis Gas Lighting Company** has announced a reduction of 20 per cent. in the price of gas for illuminating purposes after Jan. 1, 1891.

**An Electric Lighting Plant** is to be installed in the Minneapolis Union Depot shortly. This decision was reached at the last meeting of the board of directors.

**It is announced** that the government building in this city will be lighted by an electrical plant of its own, and the preliminary negotiations for the establishment of a plant are now under way.

**The St. Paul Brass Works Company** has begun the manufacture of a new type of motor and dynamo for which a working efficiency of over 90 per cent., as tested with the Prony brake, is claimed. It is the invention of Walter F. Brown, a St. Paul electrician.

**J. A. Holman,** of the Northwest Thomson-Houston Company, of St. Paul, delivered an interesting lecture on the subject of electricity before an open meeting of the Brotherhood of Steam Engineers in that city Saturday evening. His descriptions were mainly confined to the applications of electricity for lighting purposes and the various machinery used.

**Henry Villard** has been in Minneapolis several days in conference with the Edison Light and Power Company, in which he is interested in regard to electrical projects in contemplation. Last spring the Edison Company acquired valuable property and franchises at Meeker Island in the Mississippi, with a view of exploiting electricity. Mr. Villard has announced that this project has been abandoned as impracticable at the present time. The cost of building the proposed dam undoubtedly has much to do with this decision. Mr. Villard is interested in the electrical equipment of the Twin City street railway lines and inspected the work already completed during his visit. H. C. E.

## SOUTHERN NOTES.

NORFOLK, Va., Dec. 20, 1890.

**Perkins Junction, Ga.**—A company is being organized to establish an electric light plant.

**Oxford, N. C.**—Steps have been taken that will result in the establishment of a telephone exchange.

**Brenham, Tex.**—An isolated, incandescent electric light plant is being installed by A. & H. Harrison.

**Nashville, Tenn.**—An electric railroad is to be constructed by the Maplewood Suburban Home Company.

**Johnson City, Tenn.**—The Watanga Light and Power Company is building an electric line to Carnegie.

**Wilmington, N. C.**—It is stated that L. N. Cox, of Washington City, will establish an electric light plant.

**Raleigh, N. C.**—The Raleigh Street Railway Company has obtained a franchise to erect an electric light plant.

**Savannah, Ga.**—A bill has passed the Georgia legislature incorporating the Electric Railway Company of Savannah.

**Salisbury, N. C.**—The City Council is obtaining estimates for the erection and operation of an electric light plant by the city.

**Roncevert, W. Va.**—A contract has been awarded the Edison Electric Light Company for the erection of an electric light plant.

**Buena Vista, Va.**—The new street railway company recently organized here has decided to adopt electricity as its motive power.

**Little Rock, Ark.**—The City Council is contemplating the early enlargement of the electric plant owned and operated by the city.

**Lampasas, Tex.**—A company is being organized to establish an electric light plant. The mayor of the city can give further particulars.

**Front Royal, Va.**—The Front Royal & Riverton Improvement Company is interested in the establishment of an electric light plant.

**Baltimore, Md.**—The Baltimore & Powhattan Railroad Company has decided to adopt the overhead electric system of street railway.

**Mobile, Ala.**—The Mobile Street Railway Company, at a cost of $150,000, will adopt the overhead electrical system for its street railway.

**Greenville, S. C.**—A bill incorporating the Greenville Electric Railway Company has passed the Upper House of the South Carolina legislature.

**Lynchburgh, Va.**—The Edison General Electric Company has been awarded the contract to construct the new electric railway to be built in this city.

**Davis, W. Va.**—An electric light plant will be installed in the new lumber plant of the Beaver Creek Lumber Company, now in progress of erection.

**Dallas, Tex.**—The Oak Cliff Crosstown Railway Company, recently organized, has contracted for the building of an electric line eight miles in length.

**Welden, N. C.**—The Roanoke Motor Power and Navigation Company is obtaining estimates on the cost of erecting and operating an electric light plant.

**Knoxville, Tenn.**—The Knoxville and Cherokee Street Railway Company, recently incorporated, announces its intention of building an electric railroad.

**Roanoke, Va.**—The City Council will order an election for the purpose of deciding as to the issuance of bonds, $12,000 for electric lights, and $5,000 for an electric fire alarm system.

**Annapolis, Md.**—It is stated that negotiations are pending looking to the consolidation of the Annapolis Electric Light Company and the Annapolis Gas Light Company.

**Mount Pleasant, S. C.**—A bill has been introduced in the South Carolina Legislature incorporating the Mount Pleasant and Sea View Railroad Company, which will be an electric line.

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WASHINGTON, D. C., Dec. 20, 1890.

**At Marshall Hall.**—At Marshall Hall Col. J. C. McKibben is making extensive improvements in anticipation of next season. An extensive electric light plant is being installed.

**At Glen Echo** work is progressing steadily on the new power house of the Glen Echo electric line now being constructed and in which Messrs. E. & E. Baltzley are interested. They have not yet decided upon the character of power they will supply, but are inclined to favor the storage system.

**$500 Reward.**—The United States Electric Lighting Company has offered this reward to be paid for the arrest and conviction of any person or persons guilty of maliciously tampering with, or without the authority of the company in any manner interfering with the wires, cables, poles and conduits or other property of this company.

**The Votan Electric Light and Power Company** has found it necessary to increase its facilities for manufacturing the Votan electric batteries, and the factory has been moved to 1203 E street, northwest, and the offices to 502 12th street, northwest. This company is now putting up sewing machine batteries as fast as possible.

**The Proposed Postal Telegraph.**—Representative Evans, the chairman of the sub-committee of the House of Representatives Post Office Committee, having charge of postal telegraph matters, is making every effort in his power to have some positive action taken by his committee regarding the postal telegraph bills now under its supervision. V. N. B.

## ENGLISH NOTES.

*(From our own Correspondent.)*

LONDON, Dec. 10, 1890.

**The Grosvenor Gallery Break Down.**—The ill luck which continues to dog Mr. Ferranti's colossal scheme is beginning to have a most injurious effect on the clientèle of the London Electric Supply Corporation. In the *Times* of Monday there is a letter of indignant complaint from a large Regent street firm. The letter concludes as follows: "We think that you and a number of your readers will agree with us, that it is a monstrous thing that any license should be granted to a corporation professing to supply the public with what it so obviously does not possess or cannot control."

**A Curious Telegraphic Break Down.**—A curious telegraphic break down is stated to have occurred last week in connection with the political speech of the Prime Minister (Lord Salisbury) at Waterfoot. The temporary telegraphic apparatus was, it seems, installed on the previous evening in a small room in the building where the meeting was to be held, and comprised the usual Wheatstone fast speed apparatus and a quantity of the peculiar parchment-like tape employed in the transmission of the signals. This room, it appears, was damp, with the result that when the stenographers began to come in with their reports it was suddenly discovered that all the strip was spoilt, and that the whole arrangement for telegraphing full reports of the speech had broken down. The Post Office officials, however, managed to get through to the various provincial daily papers fairly full reports of Lord Salisbury's speech.

**The Electric Construction Corporation.**—A meeting of this corporation, which has just paid a 6 per cent dividend, was held on Monday. The speech of the chairman and the company's accounts showed clearly the steady progress which has been made in the last year or so towards placing the electrical manufacturing industry upon a sound and profitable basis. The Electric Construction Corporation is, I may remark, one of the very largest, if not the largest, concern of its kind in this country, and in addition to the works it already possesses, it has recently constructed works covering six acres at Bushbury near Wolverhampton. According to the chairman, the corporation has had so many orders of late that it has been compelled to refuse work, not being able to guarantee quick delivery. Besides its purely manufacturing business the company concerns itself with taking up patents and the chairman, Sir Henry Mance, seemed very sanguine as to a patent, devised by a Dr. Reedman, which his company is investigating, for obtaining phosphorus from phosphate of aluminium by means of electricity.

**Local Authorities and Electric Traction.**—The North Metropolitan Tramway Company, which is the largest in London, having a system of over 40 miles in extent, obtained powers last session to use electric traction on its lines subject to the consent of the various local authorities concerned. The scheme met with the support of the London County Council, but for some reason best known to that local authority it has been strenuously opposed by the West Ham Local Board, which, up to the present, has refused to grant permission to the company on any other than the following terms: An annual license terminable at 24 hours notice. The North Metropolitan Company is now seeking an extraordinary remedy, *i. e.*, it is promoting a bill to oblige the West Ham Vestry to conform with the terms of the act of Parliament granted to the company last session. This case is worthy of attention, as it illustrates the peculiarly stubborn opposition with which electric traction has to contend in this country. I may mention in this connection that the permission recently granted by the Hammersmith Vestry to the West Metropolitan Tramway Company to work a line three miles long on the Lineff closed conduit system was only granted after an opposition almost as great as that of the West Ham Local Board.

**Prof. Ayrton's Paper on the Chemistry of the Storage Cell.**—The discussion on Prof. Ayrton's paper on this subject, read before the Institution of Electrical Engineers on Nov. 13, still continues although it has already extended over two nights. There is much speaking, but there is unfortunately, so far as the practical electrical engineer is concerned, but little real progress toward the solution of the many obscure points in the behavior, chemical and electrical, of the storage cell. Several items of information have, however, been forthcoming from practical authorities, such as Mr. Bernard Drake, of Messrs. Drake & Gorham, and Mr. Frank King, of the E. P. S. company, which are of considerable interest. Thus Mr. Frank King informed the meeting that the E. P. S. Company are now making cells in which the current is led into the + plates at the top, and away from the — plates at the bottom. This simple alteration has he states, doubled the possible maximum rate of discharge, without affecting the capacity or durability. Mr. King also stated that the E. P. S. Company were forming their negative plates in the following manner: Two surfaces are placed in juxtaposition, and then one is moved slightly along a diagonal; the result is that each block of active material is in communication with four other ones on the opposite side, and through them with every other block of the same plate. Mr. Drake brought forward the case of a battery of accumulators used in the offices of the Peninsular and Oriental Company in Leadenhall street, which have been in use for over six years, and are still in splendid condition. This he attributes partly to the employment of a very dense acid solution (s. g. = 1.35), and remarked that he was of opinion that the question of the effect of density of solution on a cell's capacity, efficiency and durability was a subject worthy of investigation. Several speakers at the beginning of the discussion had advocated increasing the area or increasing the thickness of the negative plates to prevent them running down before the positives. In the discussion of Thursday last it was pointed out that increasing the thickness is no good, since the active material in the centre would not be touched at all and would therefore be wasted, and increasing the area compared with the positives would tend to bring other difficulties to the front. Moreover, as pointed out, I think by Mr. Drake, makers of cells intend the negatives to run down first, since if the positives are liable to do so the results would be disastrous to the life of the cell. Thus it will be seen that although fragments of interesting information came to light, there was no real solution of the purely electro-chemical questions connected with the storage cell, although at a meeting of the Physical Society on Friday, Doctor Gladstone and Mr. Hibbert described a very conclusive experiment performed by them, showing that the formation and decomposition of $PbSO_4$ accounted for the principal phenomena observed in the storage cell and that there was no necessity to suppose the formation of sub-sulphates of extraordinary compositions, such as had been modulated by Doctor Frankland.

# News of the Week.

## THE TELEGRAPH.

**Sues for Delinquency.**—At York, Neb., the district court has been trying a case in which John Bell sues the Western Union Telegraph Company for $2,500 damages. Last fall a message was received in the evening, addressed to Bell, and stating that his mother-in-law was dying, and the operator did not deliver it until the following morning. Bell claims that on account of the operator's delay he is entitled to damages.

## THE TELEPHONE.

**The Telephone in Spain.**—The regulations hitherto in force that telephone lines were not to exceed 10 kilometres in length have been abolished, and concessions for longer lines will now be granted.

**Increase of Subscribers.**—Erie Telephone Company reports an increase of subscribers for October of 127, and a total number

connected Nov. 1 of 13,065. The increase for November was 52. The total number connected Dec. 1 was 13,117.

**Long Distance Line.**—The Bell Telephone Company has a new copper long-distance wire nearly finished to Rochester, making five good copper circuits between Buffalo and Rochester. Different routes are covered so that only a general storm can cut off communication.

**Telephonic Communication with Lighthouses.**—Henley's Telegraph Works have recently manufactured a submarine telephone cable which has been laid by the pilot authorities in Finland between Hanzo, the most southern point of Finland, to a lighthouse 2½ miles from the coast. The cable has been found to work well.

**Long Distance Telephony.**—A group of French and Belgian capitalists is offering to undertake the construction of a telephone trunk line between Berlin and Warsaw, a distance of about 360 miles. The estimated cost of the line is £360,000. The syndicate proposes to hand over the line after a certain number of years to the Russian Government. The charge is to be 6 francs for the first minute's conversation, and for every subsequent minute 25 per cent. less than the charge for the preceding minute.

**Infringement Suit.**—The American Bell Telephone Company and the Metropolitan Telephone and Telegraph Company entered a complaint in the United States Circuit Court last week against John J. McAdams and Richard F. Duane, who, they claim, are infringing the patent of Alexander Graham Bell, obtained in 1876 for the Bell telephone. The complainants aver that the defendants are using a telephone other than the Bell, and that it is an infringement of the patent which they now hold. They ask that the new telephone be delivered up, and that Messrs. McAdams and Duane be restrained by an injunction from using or selling them any more, and that all the profits which they have made from them be given up to the complainants.

## THE ELECTRIC LIGHT.

**Lights in the City of Mexico.**—According to recent census statistics, there are 300 arc lights employed in street lighting.

**Concord, N. H.**—The Concord Gas and Electric Light Company has just put in a 300 h. p. feed water heater at its station.

**The Jamestown (N. Y.) Electric Light Company's** plant was destroyed by fire yesterday. Loss estimated at $30,000.

**Converters Seized.**—The customs officers at Winnipeg have seized a number of electric light converters sent from St. Paul, Minn., and valued at $1,500, for undervaluation.

**Mansfield, Pa.,** is one of the latest towns in western Pennsylvania to operate a central station plant of electric lighting. The Westinghouse alternating current system will be installed in the plant.

**New Central Station in Vienna.**—The central station of the International Electricity Company was put in operation on the 14th ult. About 21 miles of cable have been laid throughout the town and suburbs.

**Alpena, Mich.**—The capital stock of the Alpena Electric Light Company has been increased to $84,000. The increase was on account of the large extension that is to be made to the works. Among the improvements will be an incandescent light system.

**Berlin, N. H.**—The Westinghouse Electric and Manufacturing Company is now installing a central station electric lighting plant with the Westinghouse alternating current apparatus. The plant will commence operations with 750 sixteen candle power lights capacity.

**Newman, Ill.**—The town of Newman has let a contract to the Royal Electric Light Company, of Peoria, for an electric plant in that town and expects to have it in running order within a few weeks. Rantoul, Ill., is also agitating the question, and if possible will establish a plant.

**A Small Central Station.**—Perhaps the smallest Edison central station in the United States is that of Scio, Ore. This station has two No. 2 Edison incandescent machines, giving 40 lights, and four arc lights of 2,000 c. p. each. The town has about 250 people and 57 taxpayers.

**Holyoke, Mass.**—The new electric light station which is now being erected by the Holyoke Water Power Company will be equipped with four water wheels of 250 h. p. each, two 400 h. p. engines and a reserve force of another 350 h. p. engine. There will be boilers to the amount of 1,500 h. p.

**Santa Fe, N. M.**—The stockholders of the Santa Fe Electric Light and Power Company have elected the following directors for the ensuing year: E. T. Webber, of Denver, T. B. Catron, G. W. Knoebel, A. T. Grigg and C. F. A. Fischer. All contracts have been let, and the material is *en route* for putting in the Edison system.

**Estimates for Denver (Colo.) Lights.**—Inspector Jarecki has submitted the following estimates for electric lighting for the year 1891: 600 all-night arcs at $120 per year, $72,000; 1,600 incandescent lights at $26, $41,600; 46 tower arcs at $216 per year, $9,936; various departments (inside), $5,000; inspector's salary, $1,800; total, $130,336.

**Albion, N. Y.**—The Albion Electric Company, where an electric light plant of 500 lights has been operated about a year, is now compelled to increase its capacity. The central station is operating the Westinghouse alternating current system and the Westinghouse Electric and Manufacturing Company, of Pittsburgh, Pa., has received an order for its apparatus of 750 lights capacity, which will immediately be installed at the Albion point.

**Delinquent Corporations.**—In the Supreme Judicial Court, of Massachusetts, last week, before Justice Knowlton, the attorney-general obtained injunctions against the following-named Massachusetts companies for failure to pay taxes and to make returns as to condition: Massachusetts Pulsion Telephone Company, Roxbury Electric Light Company, Danvers Electric Company and the Stoneham and Wakefield Electric Company.

**Aransas Pass, Tex.**—The Aransas Pass Electric Light and Power Company, which only a few months ago started up a plant of 500 alternating current incandescent lights, has already found by experience that electric light is what the people want, and that they will have it. Hence the company has also added an arc light plant to its central station. The apparatus operated is of the alternating current system of the Westinghouse Electric and Manufacturing Company.

**Trying to Secure a Franchise.**—The Brooklyn Electric Light and Power Company has for some time been trying to get a franchise from the Brooklyn Aldermen to operate the company's plant in the Eastern District of the city. It has so far not succeeded, and last week President Cocheu of the company wrote a letter of complaint to Mayor Chapin. In his letter Mr. Cocheu appeals to the Mayor to give the company a hearing or write to the Aldermen concerning the matter.

**Keokuk, Iowa.**—The incandescent electric light is rapidly supplanting the gas lamps in many cities and towns. The Keokuk Electric Light and Power Company after having established a central station electric lighting plant of the Westinghouse alternating current system last year has just made another contract with the Westinghouse Electric and Manufacturing Company for the supply of two dynamos. With this addition, the Keokuk plant will have a capacity of 2,250 sixteen c. p. lamps.

**Windsor Locks, Conn.**—One of the most successful central station plants of incandescent electric lighting is the one established last spring at Windsor Locks, Conn. The electric light company of that town commenced operations at that time with a 500-light dynamo of the Westinghouse alternating current system. Since then the capacity of the plant has been increased twice and to-day the company is able to furnish more than four times the number of lights of its original capacity. The Westinghouse Electric and Manufacturing Company is now engaged with the installation of a 750-light alternating current dynamo.

**Lighting on a New Cruiser.**—The electric light plant on the U. S. cruiser No. 7 will consist of two engines and two dynamos, so arranged that either dynamo can be connected with any or all of the incandescent or arc light circuits. The dynamos are to produce with 400 revolutions per minute a constant electromotive force of 80 volts, the dynamos each to have a capacity of 200 ampères. As many lamps and outlets for portables, including those for running lights and signal purposes, are to be furnished as is necessary for the proper illumination of the vessels. They are to be arranged in sections, with the conductor for each section leading from a switchboard in the dynamo room. Three search light projectors of the Mangin type are also to be provided.

**Large Plant in St. Louis, Mo.**—The alternating current electric lighting plant of the Missouri Electric Light and Power Company, in St. Louis, Mo., has grown so rapidly that it has now become one of the largest central station plants of alternating current electric lighting in the United States. The company was organized in the early part of 1887 with apparatus of a generating capacity of 12,000 lights. This was the first contract for Westinghouse alternating current apparatus which had come from St. Louis. The other systems of incandescent lighting of the larger companies in America were already in operation in that city, but nevertheless the Missouri company found a very ready demand for its lights, and the success of the plant was assured from the very start. This fact very soon manifested itself when the management found that the supply at the central station was not sufficient to satisfy the demand any longer, and an increase had to be made in the generating capacity. A 3,000-light Westinghouse alternating current dynamo was added, and for a time the immediate wants of the company's patrons for lighting were complied with. But it was only temporary, and then the company added two more 3,000-light Westinghouse alternating current dynamos to the capacity of the station. The company now had a generating power by which it was enabled to furnish 21,000 sixteen c. p. incandescent lamps, which made it the largest electric lighting plant in St. Louis, but the new system of lighting had by this time gained such a popularity among the people of the city that the supply was again taxed to its utmost capacity, until a few days ago the Westinghouse company received another contract for the installation of one of its 3,000-light plants. This will give the Missouri Electric Light & Power Company alternating current apparatus with a generating capacity of 24,000 incandescent lamps, which makes it the largest alternating current central station plant in America, west of the Alleghany Mountains.

## APPLICATIONS OF POWER.

**An Electric Railway** between La Porte and Michigan City, Ind., is in contemplation.

**Ann Arbor, Mich.**—The electric railway between Ann Arbor and Ypsilanti will be built by the last of the month. Junius E. Beal is the president of the new company.

**"The Advance of Electric Traction"** was the title of an interesting paper read before the Buffalo Electrical Society last week by Mr. Frank Kitton of the Western Union.

**In Providence, R. I.,** the City Council has declined to grant an overhead electric railroad franchise on the ground that the storage battery is a safer and equally practicable system.

**Dividends.**—The West End Street Railway Company has declared a dividend of four per cent. on the preferred and five per cent. on the common stock, payable Jan. 1 to the stockholders of record Dec. 16.

**From Horses to Electricity.**—The directors of the Biddeford & Saco (Me.) Horse Railroad Company last week voted to discontinue the service until spring, when it is probable that electricity will be introduced.

**Electric Railways in the Northwest.**—Six miles of electric railway have been contracted for in Westminster, B. C., and in Astoria, Ore. The line is to be equipped with an Edison plant, and men are now at work on these roads.

**Marion, Ind.**—The city council has granted a franchise to the Marion Street Railway Company for an extension of four miles, and also to the Marion Heat, Light and Power Company for an eight-mile system. Both companies will adopt electricity, and both companies agree to begin work immediately.

**Electric Railway at Northbridge, Mass.**—Articles of incorporation have been granted to the Whitinsville Street Railway Company to conduct an electric railway at Northbridge to extend to Whitins station, a distance of 1½ miles; capital, $20,000. J. M. Lasell is treasurer and W. E. Johnson, clerk.

**Issue of Bonds.**—The Essex Electric Street Railway Company, of Salem, has received authority from the Railroad Commissioners to issue coupon bonds to the amount of $100,000, secured by first mortgage on the plant and franchise of the company. The bonds are to run for 20 years, with interest at six per cent.

**Proposed Street Railway Deal.**—Negotations are on foot for the sale of the West End and Millersville Street Railways in Lancaster, Pa., to parties controlling the Lancaster Electric Street Railway. When consummated all the lines in the city will be under the same control, electricity being used as a motive power.

**Electric Railway Installations.**—The railway department of the Chicago office of the Thomson-Houston Electric Company reports the following statement in regard to the business done from Jan. 1 to Nov. 30, 1890: Number of contracts, 64; number of generators, 74; number of motors, 647; horse power of motors, 9,940; horse power of generators, 6,130.

**More Electric Railways for Topeka, Kan.**—At the council meeting last week the ordinance granting the Rapid Transit Railway Company the right of way along Kansas avenue from Eighth to Second street was vetoed by Mayor Cofran and afterwards promptly passed over the mayor's head. For two years or more the Rapid Transit Company has been trying in vain to get over to the north side, and now that the ordinance has been passed the company will begin work at once and in the shortest possible time will have the line fully equipped and its cars running to North Topeka. The company not only guarantees to light Kansas avenue, but to spend several thousand dollars in repairing and strengthening the bridge over the Kansas River. It is specially provided in the ordinance that the cars are to be run across the bridge with horses instead of electricity. J. B. Bartholemew is president and Joseph M. Patten, general manager of the company.

**Electric Blowers.**—The C. & C. Electric Motor Company, less than 12 months ago, manufactured the first of its blower and motor combinations, with which most people are now familiar. This apparatus was primarily designed for use in dynamo and engine rooms of steamers, and in other places where it is essential to produce a rapid and thorough ventilation, and where the space is limited. Owing to the extreme compactness of the machine it may be placed in the smallest room. The apparatus was first used on the United States steamship "Baltimore," and Capt. Schley, commanding that ship, declared in a letter written to the C. & C. company that it gave "perfect satisfaction." The installation on the "Baltimore" has been followed by others on the "Chicago," "Charleston" and "Petrel," and three more blower combinations are now under construction by the C. & C. company for others of our new cruisers. The Italian navy, not to be left behind, ordered two of these blowers some few months ago, and after giving the apparatus a thorough test has recently, through its agents in Milan, placed a further order with the C. & C. company for nine plants, including six of the No. 7 or largest size machines.

## PERSONALS.

**Mr. John Caldwell,** treasurer of the Westinghouse Electric and Manufacturing Company, was registered at the Windsor Hotel, in this city, last week.

**Mr. Henry C. Payne,** a well known electric street railway man, of Milwaukee, Wis., was registered at the Fifth Avenue Hotel, in this city, last week.

**Mr. Robert S. Dobbie,** of the Edison General Electric Company, is announced to give an illustrated lecture upon arc lighting before the Brooklyn Institute on Dec. 26.

**Mr. J. Lester Woodbridge,** of the firm of Woodbridge & Turner, of this city, is announced to deliver a lecture before the Brooklyn Institute on "Electric Lighting," on Dec. 22.

**Mr. George Winn,** Superintendent of the Fire Alarm Telegraph of Allegheny City, Pa., fell from a telegraph pole last week and was instantly killed. He was repairing a wire and it is supposed received an electric shock.

**Mr. William F. Sherman,** inventor of the Sherman storage battery system for street railway propulsion, died on the 16th inst. in Lowell, Mass., aged sixty-five years. He was a wholesale dealer in jewelry in Boston until burned out in the fire of 1872.

**Mr. A. R. Bennett,** who resigned the chief management in Scotland of the National Telephone Company in July last, has signed a three years' engagement with the Mutual Telephone Company, Limited, to become its general manager and chief engineer.

## MISCELLANEOUS NOTES.

**The Aron Meter.**—Dr. Aron's electricity meter received a gold medal at this year's exhibition at Palais de l'Industries at Paris.

**Platinum.**—The greatly-increased price of platinum has naturally given rise to strenuous efforts, not only to find a satisfactory substitute, but to discover new mines. A few months ago Mexico was reported to be rich in platinum ores, and now the *Ballarat Courier* announces that ore has been found in Australia containing nearly 160 pounds of platinum to the ton.

## Industrial and Trade Notes.

**The Great Western Power Construction Company** has removed to new quarters with the Great Western Electric Supply Company, 190 and 192 Fifth avenue, Chicago.

**The Holtzer-Cabot Company** has just issued a handsome pamphlet containing a full description of the Eddy motors and showing the rapid growth of the business. This company is the New England agent for these motors.

**The Erie City Iron Works,** which manufactures hundreds of boilers for electric lighting and power plants, have very recently added to their works a set of rolls for bending steel plates 20 inches long. This machine was built to their order, and is an exceptionally fine one.

**The Western Mineral Wool Company** has issued a neat pamphlet entitled "The Use of Mineral Wool in Architecture, Car Building and Steam Engineering." It describes very minutely its applications in these branches. Besides this the results of some tests are given and some letters of recommendation from users of mineral wool.

**The Electrical Supply Company,** of Chicago, has issued a catalogue of the Edison incandescent specialties, which is well illustrated by cuts of standard apparatus well known to users of the Edison system. Detailed price-lists are given of such lighting accessories as ampère meters, cut-outs, switches, incandescent lamps, insulated wires, etc.

**The National Electrical Engineering Company,** of Eau Claire, Wis., in a very neatly printed and well illustrated pamphlet, which it has recently issued, describes very minutely the details of its direct current incandescent system of lighting. The pamphlet also contains wiring tables and various data concerning the National Company's dynamos.

**The Buckeye Electric Company,** of Cleveland, O., is the manufacturer of incandescent lamps and appliances, and has recently issued a circular letter to users of incandescent lamps, which it will doubtless take pleasure in sending to all applicants. The latter contains a statement of the capacities of the various lamps manufactured, together with prices.

**The Consolidated Safety Valve Company,** of 111 Liberty street, this city, has issued a catalogue of its specialties which is well bound in cloth covers and contains very minute descriptions of this company's valves and other steam accessories, together with various tables which are of value to steam users in general. Mr. C. A. Moore is president and manager of this company.

**W. H. Gordon & Co.,** 115 Broadway, this city, report an active demand for the Star electric switches, sockets and cut-outs, especially the sockets, which is very great, so that they have had to work the factory to its fullest capacity to keep up. They are now well stocked with switches and cut-outs and in a position to fill orders promptly. They also report universal satisfaction with these goods, which are mechanically and electrically well made.

**The Hazleton Tripod Boiler Company,** 170 Twenty-second street, Chicago, has enjoyed a brisk and steady business during the past year and looks forward to a still further increased

trade during the coming year. This company is at present erecting the second 500 h. p. for the Citizens' Electric Railway Company at Indianapolis; a 500 h. p. for an electric road in Ft. Worth, Tex.; also two 400 h. p. and one 350 h. p. for the electric road at Rock Island, Ill.

**The Electrical Supply Company,** 171 Randolph street, Chicago, has especially favorable facilities for handling the Universal arc lamp, and reports satisfactory sales. The company finds the lamps regulate admirably, and burn with a wonderfully steady and quiet arc. These lamps are intended to obviate the necessity for burning arc lights in series, with the use of high pressures, where direct currents are available. The Universal arc lamp is especially adopted to isolated incandescent plants needing a few arc lights.

**The Ashcroft Manufacturing Company,** of 111 Liberty street, this city, well known as the manufacturer of pressure and vacuum gauges, Tabor's steam engine indicators, and other steam users' accessories, has issued to the trade a catalogue of its specialties, which has been solidly bound in cloth, and is a valuable book for steam engineers, not only because of the information it contains in regard to this company's manufactured articles, but for its useful information in regard to shafting, bearing metals, and various other matters.

**The Columbia Incandescent Lamp Company,** 1,312 Olive street, St. Louis, Mo., has issued a very neat catalogue, showing its type of lamp adapted to the principal sockets now in the market. So handsome a catalogue should have a place on every electrician's desk, more especially as the lamps have won their way to their present high position through their long life, high efficiency and even diffusion of light. This company makes a special lamp adapted for use in street railway cars, the filament of which is so mounted as to prevent mechanical injury from vibration.

**The Rhode Island Telephone and Electric Company,** of Providence, R. I., owing to the burning of its glass factory, has been delayed in filling orders for the "Little Giant Battery," but is now in shape again. This company was never so rushed as at present. In addition to its large sale of batteries it has now several hundred private telephones in factory exchanges. At present the company is equipping the different departments of Armington & Sims' factory with 12 Bell telephones, and has lately equipped the factories of the Corliss Steam Engine Company, Brown & Sharpe, and R. Hoe & Co., New York.

**The Burton Heater Company,** of Richmond, Va., is placing the Burton electric heaters, during the present season, in electric cars at St. Louis, Kansas City, Sedalia and Joplin, Mo.; Denver, Colo.; Omaha, Neb.; Des Moines, Ia.; Indianapolis, Ind.; Lynn, Mass., and other places, and the reports so far received of them have invariably been favorable. These heaters have also been placed in the elegant private car of the Short Electric Railway Company, of Cleveland, O., and Mr. S. H. Short, President of the Short Company, after having them thoroughly tested, says of them: "They are fully up to standard and we have no criticisms to make of them."

**Berlin Iron Bridge Company.**—The new pulp mill of the Manufacturing Investment Company, at Madison, Me., is fast approaching completion, and is constructed of brick and iron designed and built by the Berlin Iron Bridge Company, of East Berlin, Conn. The machine shop is 72 feet wide by 185 feet long and one stories high; the wash room is 74 feet wide by 182 feet long and two stories high; the digester building is 62 feet wide by 221 feet long and three stories high; the wheel house is 73 feet wide by 78 feet long and two stories high. In the large room the arc system is used and around the machinery the incandescent system. The company is now negotiating for the electric plant.

**The Wainwright Manufacturing Company** of Massachusetts has, through its New York manager, Mr. F. B. Aspinwall, 121 Liberty street, received the order to furnish the new plant of the Brooklyn Municipal Electric Light Company, of Brooklyn, N. Y., with two of its compound condensing feed-water heaters, of 300 h. p. capacity each. This heater was given the preference over all others, on account of its high duty and efficiency in connection with engines of the compound type. The above company reports that the demand for its heaters is steadily on the increase, and it has at the present time close to 250,000 h. p. in daily use, and in every case they are said to give perfect satisfaction.

**The Pettingell-Andrews Company.**—The sales of this Boston company for the S. S. key and keyless socket manufactured by this company are enormous, over 100,000 being now in use. The K. W. specialties are also in better demand than ever. F. A. Pettingell has just returned from a very successful business trip in the West, and reports booming business. D. A. Andrews, Jr., just home from New Orleans and the South, says that trade is very satisfactory indeed. Levi Cofren, the persistent New England agent of this company, has recently secured several large orders for Okonite and other line wires and supplies in New England. The Pettingell-Andrews Company declared a five per cent. semi-annual dividend Dec. 1, 1890.

**Messrs. Partrick & Carter** have removed to their new buildings, 125 South Second and 131 Gothic street, Philadelphia, where they will have greatly increased space, machinery and working force. Their new buildings give them more than 20,000 square feet of floor space, and they have added new machinery of the most improved form. They report trade as being good and their annunciators and fire alarm systems and house supplies are in demand. The popularity of this firm among the trade is owing to the superior quality of the supplies made and sold by them and to the policy of the house in not entering into competition with the trade, as Partrick & Carter do no construction or wiring work, manufacturing exclusively for the trade. The hurry and confusion of moving their establishment will necessitate some delay in filling orders, but a few days will overcome that.

**A Big Order.**—The Electrical Supply Company, 171 Randolph street, Chicago, is accustomed to large orders and seldom or never refers to anything less than a car load, but when it comes to three car loads, as was the case last week, it "makes a distinction." Our friends of the Electrical Supply Company were notified by telegram that they could have an order for 110 miles of No. 6 Shield Brand line wire if it could be shipped immediately, and an idea of the stock carried by the Electrical Supply Company and its facilities for shipping can be gathered from the fact that although it was noon before the order was received—the 55,000 pounds of wire were delivered to the railroad company before 5 o'clock. The Electrical Supply Company extends a cordial invitation to all interested to call and inspect the stock carried and its facilities for meeting almost any emergency.

**The Taylor Manufacturing Company** of Chambersburg, Pa., is selling numbers of their automatic engines for electrical service, both lighting and railway work, and the satisfaction that the "Beck" engines give justly entitles them to the rank they have taken in the electrical industry. Recent sales are reported as follows: one 14 × 15 engine, to the Ft. Scott (Kansas) Rapid Transit Railway Company, making the second engine installed for this company, operating its electric railway generators; two 11 × 12 engines, with complete steam plant, for the Chartiers Valley Electric Light Company, of Mansfield, Pa.; two 10½ × 12 engines, with boilers, etc., for the Thomson-Houston Electric Light Company, of Bloomsburg, Pa.; one 9½ × 12 engine to Millville, N. J., Schuyler Electric Light Company; one 12½ × 15 engine, with complete steam plant, for Uniontown Street Railway Company, of Uniontown, Pa., operating railway generator; also six 10 × 10 engines for the Steamers 'Delaware," "Erie," "Passaic," "Jay Gould," "Jno. King" and "Pavonia" of the Erie line, through Messrs. Cooke & Co., of New York, and one 8½ × 10 engine to Cooke & Co.

**Visitors** to Alexander, Barney & Chapin's store in the Telephone Building, No. 20 Cortlandt street, this city, have sometimes found it difficult to push their way through the crowds of people gathered there, and the heaps of barrels and boxes which are piled up on every side. To provide breathing space for their business, which has increased wonderfully, although the store has been in operation but a little over two months, Alexander, Barney & Chapin have arranged to add to their present quarters the large basement which runs beneath, and will fit this up with all conveniences for a storehouse and packing and shipping department. Although at first it was thought their original accommodations would be sufficient for at least a year, their business demands more room, and this additional floor will enable them to carry even a larger stock of goods and will facilitate the handling of the same, thus giving the firm reason to think that they can in future make even a better record for promptness than they have enjoyed in the past. An electric elevator will connect the basement and first floor, which will be both useful and interesting, as a mark of further electrical progress.

## Answers to Correspondents.

**Lamp Rheostats** (M. J. McG.).—The rheostat for regulating the power of incandescent lamps is almost as old as the incandescent lamp itself, and the apparatus arranged by Mr. Doyle, recently described in our columns, is simply an improvement in details.

**Book on Wiring.**—What book can one get that would give the best account of all sorts of wiring? R. T.

The little books by Badt and Davis are as satisfactory as any we know of for general work.

**Induction Coils.**—Is a Ruhmkorff coil, in which the secondary coil is wound with No. 36 bare wire, the two ends only being wound and a space left in the centre filled with resin, as powerful as one wound clear across with the same size of double silk insulated wire? AMATEUR.

The insulation of bare wire with varnish is so difficult that it is not to be recommended, except for galvanometer coils in which high potential will not be used. Aside from this, leaving a space in the centre is disadvantageous. If the entire length of the core is not covered with winding the best place to put it is on the central portion, allowing the ends of the core to project.

**E. M. F. of a Series of Cells.**—I wish to take 24 cells of battery and connect them in a series; these cells have an electromotive force of 1.8 volts, each an open circuit, and an external resistance of .8 of an ohm; what would be the greatest potential that can be observed, and what are the two points between which it exists? A. A. H.

The potential at the terminals will vary with the current which is drawn from the batteries; its maximum value will be substantially 24 times 1.8 volts, and will be observed on what is practically open circuit. The maximum of electromotive force would always be between the extreme ends of the series.

**Removal of Sulphate from Battery Plates.**—Can you tell me whether the sulphate can be removed from storage batteries plates? If so, how? W. A. R.

A certain amount of sulphating occurs during the normal action of the battery, with which one need not be concerned. If a permanent deposit of sulphate occurs at any point and is not reduced by the action of the battery it may be scraped off.

**Direct Currents Without a Commutator.**—(1) Is there any known method of obtaining a direct current from a dynamo without the use of a commutator? (2) I have never seen any description of such a method, and if you know of any papers on the subject will you please state where they can be obtained? (3) Would a method of construction for obtaining a direct current without the use of a commutator be of any commercial value if in practical operation? O. F. P.

(1) There is at least one such method, but nothing as yet made public seems to be practicable for high voltages. (2) See THE ELECTRICAL WORLD for Sept. 13, 1890, where a modification of Faraday's disc machine is described. (3) A dynamo that would give continuous currents of say 100 volts electromotive force and with reasonable simplicity and efficiency would have a great commercial value.

## Business Notices.

**E. H. Cocliot, 44 Rue Taitbout, Paris,** solicits correspondence with a view to introducing in France American electrical apparatus and machinery.

**Complaints of gas lighting** plants stopped by our battery cut-out. Cheap, sensitive, reliable. Electric Supply Company, 105 South Warren street, Syracuse, N. Y.

**Intelligent people,** who are familiar with the respective advantages which are offered by the several competing railroad lines between Chicago, St. Louis and Kansas City, and who desire to travel with the utmost speed, safety and comfort, always take the popular and reliable Chicago & Alton Railroad between these points, and passengers going to or coming from the South, via St. Louis, or when going to or coming from the West, via Kansas City, should insist upon having tickets that read over the Chicago & Alton. It is the only road with three complete and elegantly equipped trains daily between Chicago and each of the points named, and no railroad managers in America have a more intelligent appreciation of the wants of the traveling public than do those of the famous Chicago & Alton.

MINNEAPOLIS, Minn., Dec. 3, 1890.

*Mr. F. J. Renz:*

DEAR SIR: In reply to your letter of the 3d in regard to testimonials, will say that I am so well pleased with the Perret Motor *in all* respects that I will permit your people to write anything they see fit over my name, providing it is *all in favor of* the *Perret*, and will do all I can in any way to help you in Minneapolis.

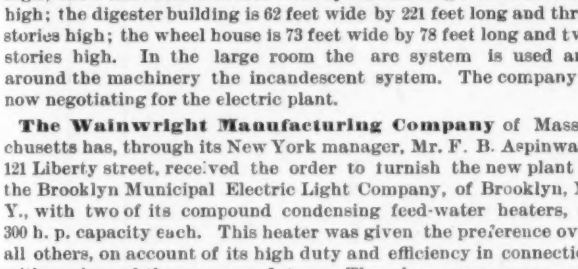
F. G. WARD,
Manager Great Atlantic & Pacific Tea Company.

# OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS

### U. S. PATENTS ISSUED DEC. 16, 1890.

**442,610. Station Indicator;** Louis Casper, of Cheyenne, Wy. Ter. Application filed Sept. 11, 1888. In a station indicator, the combination, with a car axle having a ring provided with a tooth, a polygonal notched wheel having a projection, a swinging contact-closer, electrical contacts at the sides of the same, a casing surrounding the above mechanism, electromagnets connected with the electrical contacts, a roller operated by said electromagnets, and a band secured to the roller and bearing the station names.

**442,617. Electric Arc Lamp;** John E. Giles, of Hazleton, Pa. Application filed Aug. 21, 1889. In an arc lamp provided with a fixed feed-regulating wheel train, a detent for the train, a shunt coil for releasing the detent, one of the wheels of the train being



No. 442,856.—MEANS FOR REDUCING INDUCTIVE DISTURBANCES IN TELEPHONE CIRCUITS.

mounted on a movable axis, and a main coil for lifting the movable wheel and springing the arc.

**442,623. Electric Trolley Switch and Trip;** Richard C. Hopson, of Saginaw, Mich. Application filed May 5, 1890. An electric trolley-switch and junction-trip consisting of main wire and switch wire clamped together at terminal of switch, the switch wire over and a few inches above main wire, and a concave switch plate extending from the junction of the wires, with one end pressed against the main wire, the other end secured to the switch-wire, the two wires being stayed by a brace at the middle of switch-plate, the switch-plate thus serving to divert the trolley upon the switch-wire, and the said switch-plate having at its point of junction with the main wire a hanger extending below the switch-plate, and far enough from it to admit of the passage of the trolley-wheel, and being long enough to engage a "trip" that may be upon the trolley, whereby the switch-plate is pulled away from the main wire, and the trolley allowed to pass the switch-plate without being diverted on to the switch-wire.

**442,649. Electric Heater;** Charles H. Talmage, of Kansas City, Mo. Application filed April 11, 1890. A heater or transformer consisting of a closed secondary circuit of a sheet-metal cylinder surrounding the primary coil, said sheet-metal cylinder being separated from the primary coil by a plaster of-paris insulation, whereby the current is conducted circumferentially, the magnetic lines of force at right angle thereto, and the heat radiates from the surfaces.

**442,654. Portable Electric Motor and Cloth-Cutting Machine;** Elbert D. Weyburn, of Chicago, assignor to the Weyburn Special Machine Company, of same place. Application filed April 5, 1890. The combination of a suspended track of indefinite length of an electric motor mounted in a movable frame upon said track, a source of electricity, wires connected with said source of electricity and in operative proximity to said track, electric connections attached to said motor; and connected by trolleys with said wires, a flexible shaft connected with said motor, a cloth-cutting machine in operative connection with said shaft, and a switch-lever attached to a cord trained over a pulley upon said movable frame, whereby said cloth-cutting machine may be moved from table to table, the motors transported therewith by means of said flexible shaft and stopped or started by means of said suspended cords in operative proximity to the cutting-machine.

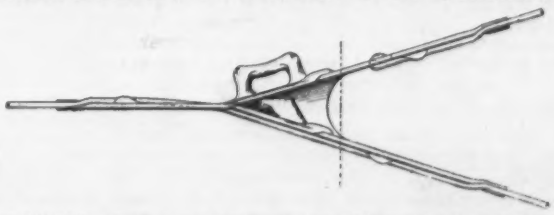
**442,666. Bracket for Combined Electric and Gas Lighting;** John Gunn, of New York. Application filed March 12, 1890. The invention involves a joint for a bracket arm in which are two pairs of rings sealed in insulating material, and adapted to revolve one upon the other; one pair of rings is connected with battery, and the other with the swinging arm whereby the arm may be moved completely round.

**442,668. Regulation of Electric Motors;** Edwin Wilbur Rice, of Lynn, Mass. Application filed Oct. 20, 1890. The method of regulation for preventing injury to an electric motor upon starting from a state of rest, which consists in maintaining in series circuit with the armature of the motor a counter-potential generator until the speed of the armature becomes such as to generate of itself sufficient counter electro-motive force to render injury from the passage of an excessive circuit no longer liable, and then shunting or disconnecting from circuit the said counter-potential generator.

**442,685. Electric Light Holder;** Joseph B. Moore, of Minneapolis. Application filed June 20, 1890. The combination with a lamp of a plate arranged upon the top of the socket of said lamp and projecting therefrom, a thimble securing said plate in position, and a spring secured to said plate.

**442,705. Electric Meter;** Alexander W. Meston, of St. Louis, Assignor to the Emerson Electric Manufacturing Company, of same place. Application filed July 22, 1890. In an electric meter, the combination, with a solenoid and its core and a lever actuated thereby, of a revolving surface having teeth increasing in number along the generating line of said surface, and gear carried by the lever, said gear arranged to engage with the teeth on said revolving surface.

**442,734. System of Telegraphic and Telephonic Exchange;** John R. Smith, of Neosho, Mo., and Wallace Childs, of Fort Smith, Ark. Application filed Sept. 27, 1889. In a system of telegraph or telephone exchange having independent transmitters and receivers connected in open circuits converging in a central station and terminating in switch-paths, the combination of a belt in electrical connection with each of said circuits and provided with an electrode, and wheels for supporting and operating said belts over the switch-paths, and an electro-magnet propelling device therefor in a line from one of the stations, whereby said electrode



No. 443,081.—TROLLEY SWITCH FOR ELECTRIC RAILWAYS.

may be guided and moved into connection with each of the circuits terminating in the said switch-paths.

**442,744. Storage-Battery Electric Car;** John Stephenson, of New York. Application filed Aug. 2, 1890. A car with foot-panel hinged at its lower verge and with a guard rail arranged to support the panel in a horizontal position with supports from the car-body sill.

**442,746. Pendant Cleat;** Arthur R. Bush, of Boston, Mass., Assignor to Paine & Francis, of same place. Application filed June 4, 1890. The invention comprises a pendant cleat consisting of members, one member having a cavity on its rear side and provided with three holes, extended from said cavity to the outside of the lower member binding screws secured to said member, and screws to secure to the other member an incandescent electric light having its insulated wires extended through one of the holes into the cavity and provided therein with a knot the ends of the said

wires being extended out through the other holes and secured to the binding screws.

**442,799. Train Telephone;** Robert S. Carr, of Hamilton, O., Assignor of two-thirds to W. B. Carr and George P. Stevenson, both of same place. Application filed Feb. 17, 1890. In a train telephone the combination of a locomotive and car, each provided with an air pipe, a flexible pipe connecting said two pipes, air brake mechanism upon the car connected with the air pipe of said car, an air reservoir and valve at said locomotive in communication with said air pipe thereof, mouthpieces in said locomotive and car in communication with the air pipes thereof and a diaphragm in each mouthpiece exposing one side to its mouthpiece and the other side to the compressed air which may be contained in said air pipes.

**442,800. Reversing Key;** Edward A. Colby, of Newark. Application filed Feb. 24, 1890. The invention comprises a support having an opening which contains a sleeve or bushing in which a key rotates. A projection on the key enters a slot in the sleeve. Bifurcated contact pieces insulated from each other are secured on opposite sides of the projection making contact with four contact plates disposed around the opening in the support.

**442,808. Telegraphy;** Adolph G. Hummel of New York, and Frank A. Graham, of Brooklyn. Application filed July 10, 1890. In a system of telegraphy, a central station and one or more local stations connected therewith by a main circuit, a bell at each station normally in the said circuit, a ticker or equivalent receiving apparatus at each of the stations, and a pole charger or equivalent transmitter also at each station, and a switch at each station with a normal one which throws the bells into circuit, another set capable of throwing in one pole of transmitter and the ticker at the same station for receiving, and the third set capable of throwing in both transmitter poles and the ticker for sending and a key in the bell circuit at each station, whereby it is possible to call from either station, and whereby the message is recorded at both the sending and the receiving station.

**442,816. Safety Device for Overhead Conductors;** Robert A. Morgan, Jr., of Boston. Application filed March 14, 1890. The invention consists in a device for overhead conductors, comprising a rigid member, a spring member, and a locking device, whereby the spring member is secured to the rigid member and held locked thereto, while the overhead conductor remains intact, but is disconnected from the rigid member by the action of the spring member when the said conductor becomes broken.

**442,843. Electrical Measuring Instrument;** Edward Westom, of Newark, N. J. Application filed July 1, 1890. In an electrical measuring instrument, a coil, a second coil supported between two filaments connected to the opposite sides and in the field of force of said first coil, and means for indicating the extent of ritary movement of said second coil, said coils being electrically connected.

**442,849. Automatic Recording Apparatus for Vehicles;** Josef Bellussich, of Capo D'Istria, Austria-Hungary. Application filed July 11, 1889. The apparatus comprises a plurality of electric circuits, each including an electro-magnet, a style operated thereby, and a circuit closer. The circuit closer for the electro-magnet that operates the style which records the running time of the vehicle is controlled by the motion thereof, while the circuit-closers for the electro-magnet that operates the styles which record the time of occupancy of the vehicle are controlled by the passenger on taking his seat; also, in combination with these devices, of automatically operated means that alternately and periodically cut out and restore the electro magnets; also, a record card in reach of the styles, and a mechanism for imparting a uniform motion to the card. The said means may be operated either by a time mechanism or by a mechanism timed by the speed of the vehicle, while the record device for recording the running time of the vehicle may be controlled by the vibrations or oscillations of the vehicle or by the motion of one of its wheels.

**442,856. Means for Reducing Inductive Disturbance in Telephone Circuits;** John J. Carty, of New York. Application filed Sept. 18, 1890. Three or more metallic electric circuits extending parallel to each other, combined with means, such as lateral branches or condensers, connected with the central circuit and extended along the more distant conductor of the side circuits, whereby each conductor of the said central circuit is enabled to exercise equal and like electrostatic inductive effects upon both near and distant conductors of its adjacent side circuits.

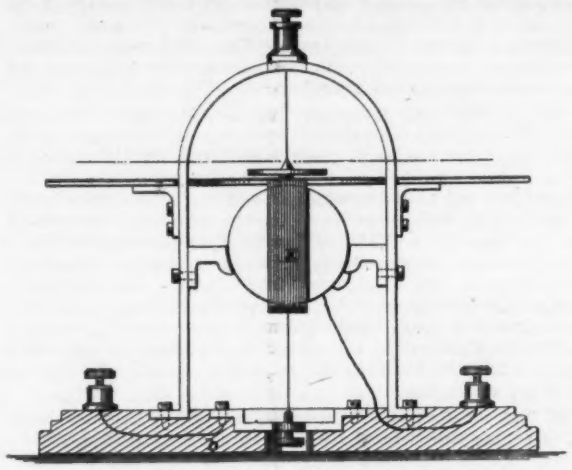
**442,868. Underground Conduit for Electric Conductors;** Josiah S. DuBois, of Camden, N. J. Application filed March 15, 1886. In an underground conduit, the combination of asphalt or brick conduit, a frame secured therein, having supporting brackets and anchor pieces, tubes or troughs supported upon said brackets, provided with longitudinal slots and flanges, a clamping plate, corresponding to the brackets, and bolts adapted to clamp said flanges and clamping plates together.

**442,870. Dynamo-Electric Machine or Motor;** Nathan H. Edgerton, of Philadelphia. Application filed Oct. 22, 1890. In a dynamo-machine or motor, a frame forming a double yoke for the field magnets, consisting of two sections, one of said sections forming three sides of the frame and the other section forming the remaining side and united at their meeting ends, said frame formed with oppositely-located bearings for the armature shaft, and means for securing the field-magnets to and within said frame.

**442,880. System for Indicating Thermometric Records;** Henry Jansen Haight, of New York. Application filed May 3, 1888. A case of electrical instruments mounted in said case, circuit wires connected with said instruments, and a hinged door for closing the case in combination with a tube concentric with the hinge of the door, through which tube the said circuit-wires are extended into the case.

**442,881. Means for the Transmission of Meteorological Indications;** Henry Jansen Haight, of New York. Application filed Nov. 29, 1889. A multiple transmitter, comprising a plurality of fixed contacts or electrodes, and a circuit-closer having a step-by-step movement and adapted to bring said fixed contacts or electrodes one by one into electrical connection with one pole of an electric generator, and an indicating instrument having a movable index and two magnets controlling the same, said magnets being in electrical connection with the opposite pole of said battery, in combination with two metallic strips in electrical connection with said magnets, respectively, contact-plates in electric connection with said fixed electrodes of said multiple transmitter, a portion of said contact-plates co-operating with one of said metallic strips and a portion of said contact-plates co-operating with the other metallic strip, and movable circuit-closers for establishing electric connection between said contact-plates and said metallic strips.

**442,882. Multiple Circuit Closer;** Henry J. Haight, of New York. Application filed March 14, 1890. A rotary arbor, a plurality of insulated electrodes the contact surfaces of which are in a circle having said arbor as its centre, the contact surface of each



No. 442,843.—ELECTRICAL MEASURING INSTRUMENT.

electrode being perpendicular to a radius of said circle, an electric generator, a plurality of electric indicating instruments arranged in multiple, all being in electric communication with one pole of said generator, and a plurality of electric circuit wires, each wire connecting one of said indicating instruments with one of said electrodes, in combination with a circuit closing arm carried by said arbor and adapted to make contact with said electrodes in succession, said circuit-closing arm being in electric communication with the opposite pole of said electric generator.

**442,883. Combined Electric Indicating and Telephone System;** Henry J. Haight, of New York. Application filed May 9, 1890. An electric signaling circuit including signaling devices; an electric generator, a line wire and a return wire, in combination with electric indicating circuits, said indicating circuits being two in number, viz: First, a multiple circuit closer circuit, including electric means, such as relay magnets for operating multiple circuit closing instruments, an electric generator, means for opening and closing said circuits for operating said relay magnets, and a line wire, and second, an indicating instrument circuit, including electric means, such as relay magnets for operating electric indicating instruments, an electric generator, means for opening and closing said circuit and a line wire independent of the line wire of said multiple circuit closer circuit, the line wire of one of said two indicating circuits being the same as the line wire of said signaling circuit, and the line wire of the other indicating circuit being the same as the return wire of said signaling circuit.

**442,932. Electric Cooking Apparatus;** Ernest Abshagen, of Chicago, Assignor, by direct and mesne assignments, of five-eighths to Geo. M. Clark, Henry M. Hubbard and Henry H. Hubbard, all of same place. Application filed Aug. 4, 1890. The electrical cooking apparatus, consisting of a closed vessel or receptacle filled with an oily fluid and provided with suitable cooking compartments heated by said fluid, and a resistance piece immersed in said fluid and in circuit with a generator of electricity.

**442,933. Electric Steam and Hot Water Generator;** Ernest Abshagen, of Chicago, Ill., Assignor, by direct and mesne assignments, of five-eighths to Geo. M. Clark, Henry M. Hubbard and William H. Hubbard, all of same place. Application filed Aug. 4 1890. An electrical steam and hot water generating apparatus consisting of a closed vessel having an interior compartment in contact with the water, a body of oily fluid in said compartment, and a resistance piece immersed in said oily fluid and in circuit with a generator of electricity.

**442,954. Method of Welding Metals Electrically;** Charles L. Coffin, of Detroit, Mich. Application filed June 9, 1890. The method of electrically welding metals, consisting in connecting each article with one pole of a generator of electricity, making contact between the ends to be welded, and an electric conductor of equal or less resistance, passing a heating current through said articles and said conductor, and completing the weld by pressure.

**442,969. Portable Electric Lamp;** Desmond Gerald Fitz-Gerald and Arthur Henry Hough, of London, Eng., Assignors to the Mining and General Electric Lamp Company, Limited, of same place. In portable lamps, a vessel containing or constituting the cell or cells inclosed in an outer casing, between which casing and the said vessel is interposed elastic material.

**442,996. Electric Switch;** John O'Brien, of New York. Application filed Aug. 28, 1890. In an electric switch, the combination of the pivoted switch levers, the pairs of connecting plates, the lightning arrester, telephone, a connection between the lightning arrester and the telephone, a connection extending from one of the contact plates directly to the telephone, and connections with the line-wires and the ground.

**443,004. Trolley-Line Switch;** William M. Ramsey, of Allegheny, Pa. Application filed Aug. 7, 1890. A trolley-line switch or cross-over, consisting of a base-plate, provided with a series of slots, a clamping-disc and means for securing the two plates together. The switch-bars are attached between the said plates in a manner that the same may be adjusted towards or away from each other, whereby a cross-over of any desired angle may be formed.

**443,005. Trolley-Line Insulator;** William M. Ramsey, of Allegheny, Pa. Application filed Aug. 7, 1890. A trolley-line insulator, consisting of a bracket having a tapering circular opening formed therein and two upwardly extending hooks. A cylindrical block is confined in said opening, and a bolt secured therein with a shoe or clamp attached to said bolt.

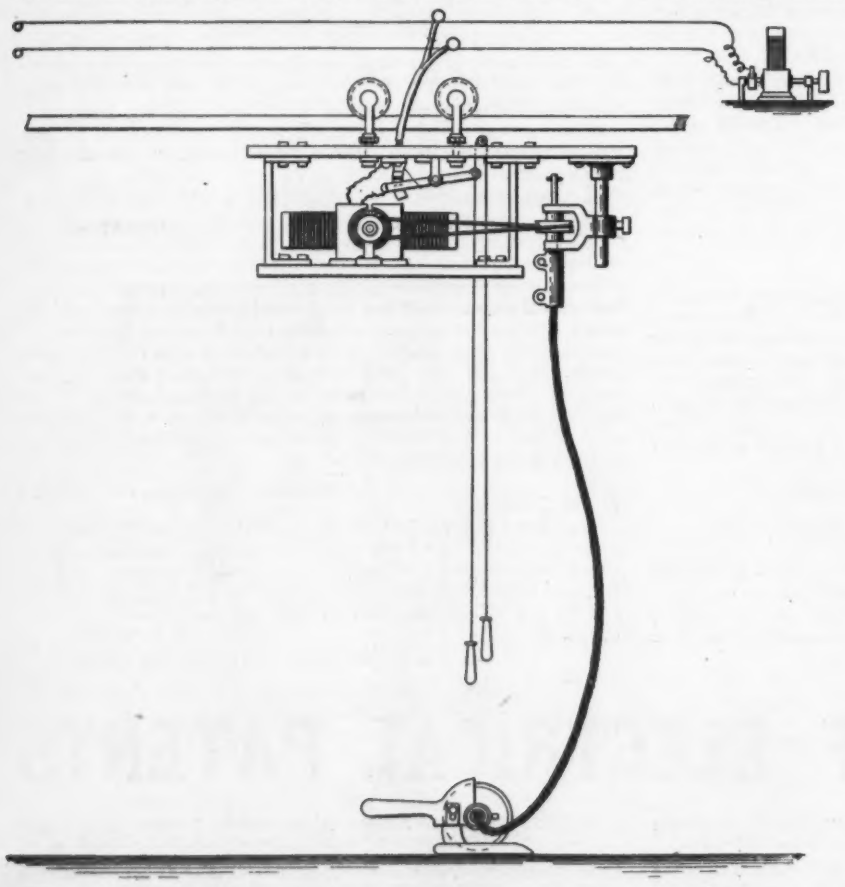
**443,019. Magnetic Shield for Electric Motors;** Charles J. Van Depoele, of Chicago. Application filed Aug. 4, 1887. The combination with an electric motor and a vehicle upon which said motor is mounted, of a sheet-iron casing constituting a magnetic shield and permanently interposed between the motor and the interior thereof, whereby the passage of magnetic lines from the motor to the interior of the vehicle is prevented.

**443,042. Magnetic Ore-Separator;** George S. Finney, of Chicago, Assignor to the Rotary Magnetic Ore Separator Company, of same place. Application filed March 25, 1890. A magnetic wheel for a separator, comprising a series of electromagnets having a common core and having the poles extended from opposite ends of the series crosswise of the plane of the wheel's circumference, and forming elements of its cylindrical surface.

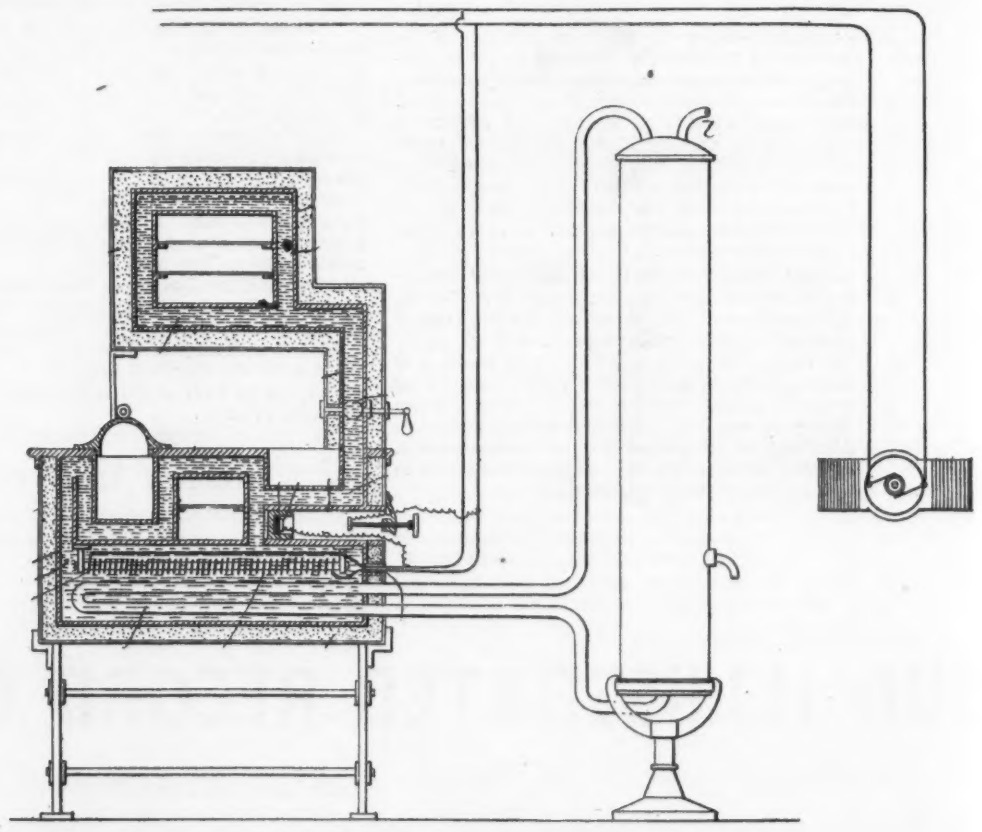
**443,043. Magnetic Separator;** George S. Finney, of Chicago, Ill., Assignor to the Rotary Magnetic Ore Separator Co., of the same place. Application filed March 25, 1890. A magnetic wheel for a separator, comprising a series of magnets on a common rotary core and alternating as to polarity, and each having its poles extended continuously around the plane of the wheel's circumference and forming elements of its cylindrical surface.

**443,044. Magnetic Ore-Separator;** George S. Finney, of Chicago, Assignor to the Rotary Magnetic Ore Separator Co., of same place. Application filed March 25, 1890. A permanently magnetic wheel for a separator, comprising a rotary shaft carrying heads and permanently magnetic bars, extending lengthwise between the heads, alternating in polarity around the wheel, and forming elements of its cylindrical surface.

**443,048. Method of Protecting Buildings from Lightning;** Nathaniel D. C. Hodges, of Plainfield, N. J. Application filed Sept. 28, 1889. The method of protecting buildings from electric discharge, which lies in interposing at some part of the lightning rod or in the probable path of the discharge in lieu of such rod a substance for receiving and absorbing said discharge by virtue of its characteristic structure, preferably a substance in a diffused or finely comminuted state, whereby the potential of said discharge becomes reduced or destroyed.



No. 442,654.—PORTABLE ELECTRIC MOTOR AND CLOTH CUTTING MACHINE.



No. 442,932.—ELECTRIC COOKING APPARATUS.

**443,068. Electric Cut-Out;** David J. Cartwright, of Boston, and John S. Potter, of Newton, Mass.; said Cartright Assignor to said Potter. Application filed July 14, 1890. An electric cut-out consisting of a base-piece having a cavity containing metallic locking and contact pieces, exterior metallic brackets and metallic screws securing the said brackets in place on the rim of the base-piece and extending through the latter into engagement with the interior metallic locking plates for attaching and metallically connecting said plates with the exterior brackets.

**443,074. Electric Signaling Device for Moving Vehicles;** Otis J. Depp and Schuyler J. Munn, of St. Louis, Assignors of one-fourth to Peter M. Kling, of same place. Application filed Aug. 4, 1890. An electric lighting device for moving vehicles, consisting of a circuit-controlling device located within the brake or switch handle of a car, an electric bell located on the said vehicle, a three-line circuit connecting the said bell with the circuit-controlling device, and means whereby electricity is supplied to the said wires from the trolley or main line.

**443,081. Trolley Switch for Electric Railways;** John Jones, of New York, Assignor of two-thirds to C. P. Stevens, of Denver, Colo. Application filed Sept. 25, 1890. This invention consists of a Y-shaped casting provided near the apex with recesses containing swinging gates or flaps which are held in their normal position in the recesses by gravity and provide a free path for the trolley wheel when traveling in one direction, but are adapted to be swung out of the recesses by the trolley wheel when traveling in the other direction and thus switch the trolley to another line.

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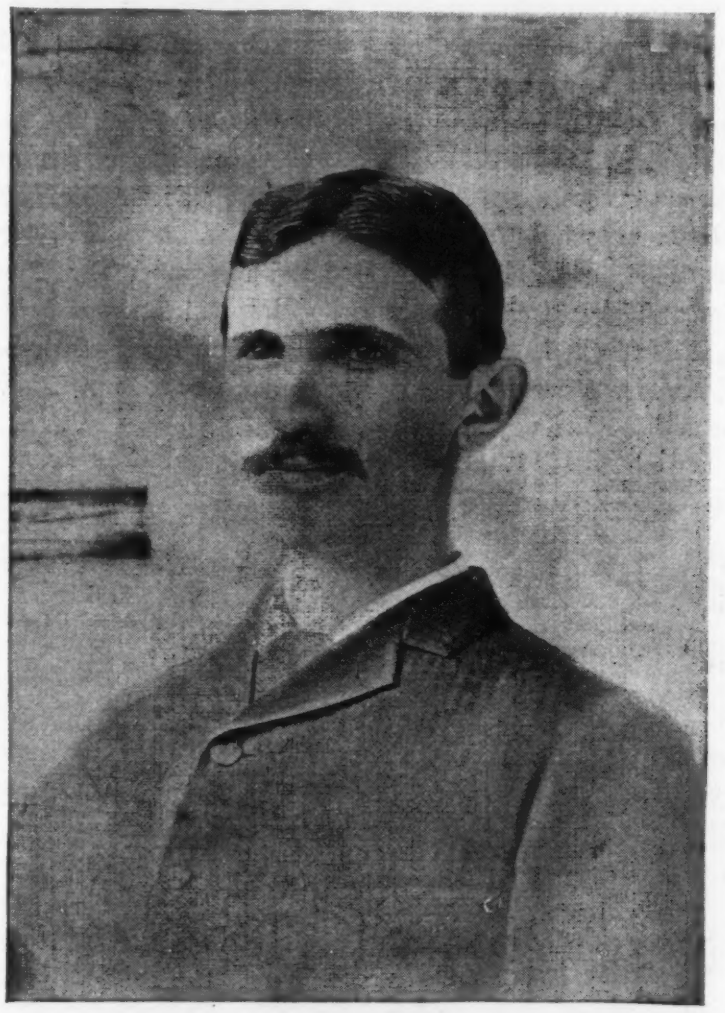
*Copies of the specifications and drawings complete of any of the patents mentioned in this record—or of any other patents issued since 1886—can be had for 25 cents. Give date and number of patent desired, and address The W. J. Johnston Co., Ltd., Times Building, N. Y.*

# ELECTRICAL PROGRESS OF 1890,

AS CHRONICLED BY

# THE ELECTRICAL WORLD.

**It is a Pleasant Task to Record Twelve Months of the History of Modern Electricity**, for 1890 has been a period of steady and rapid growth that has placed the electrical industries far in advance of what they were a year ago, and is full of promise for the future. It has been the privilege of THE ELECTRICAL WORLD to follow up the splendid successes achieved by electricity and to record the progress made. The great activity in every



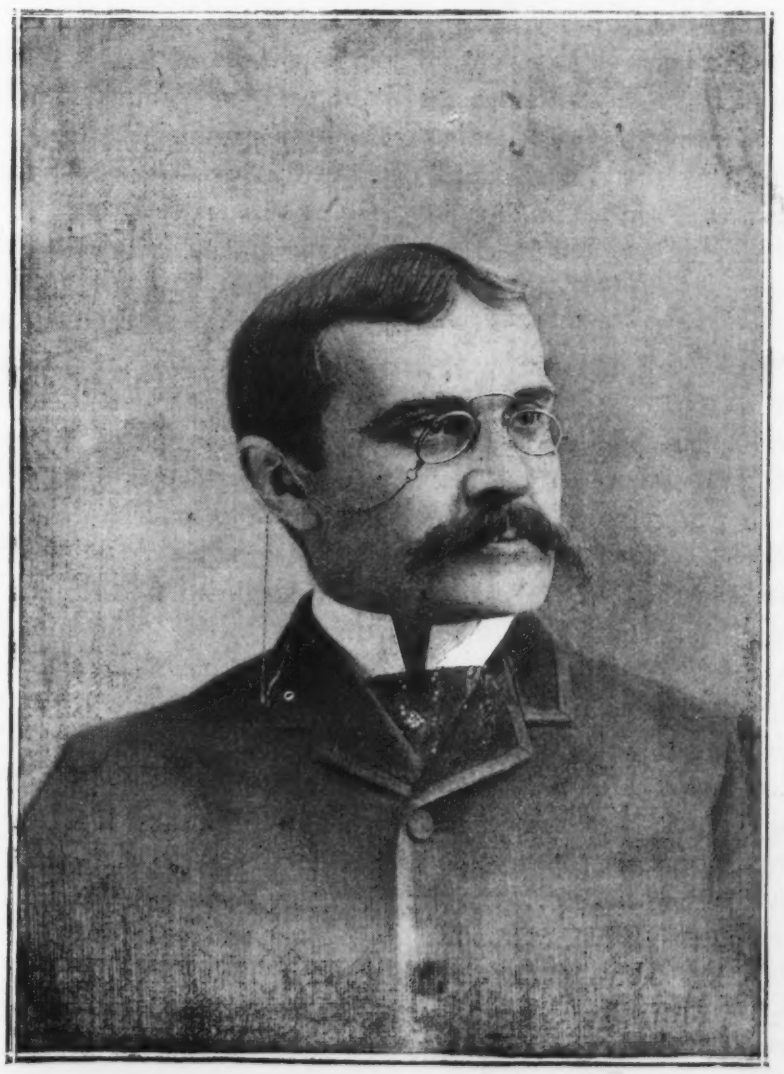
NIKOLA TESLA.
Vol. XV, Page 106.

department of electrical application and development during the year, the numerous important inventions to be described and illustrated, the growing volume of electrical news, the rapidly increasing number of valuable articles and papers that must be presented to the readers of a representative journal like THE ELECTRICAL WORLD, have rendered necessary a material increase in the size of the paper. In fact the two volumes for the present year have nearly a hundred more pages of reading matter than the two volumes of 1889. It is instructive to glance at the current volumes and see what an amount of electrical literature is therein contained.

**Volumes XV and XVI of the Present Year have over Nine Hundred Pages of Reading Matter**, each page being equivalent to not less than eight pages of an octavo book. Fancy a yearly record of electrical progress in seven corpulent octavos of a thousand pages each!

A single number of THE ELECTRICAL WORLD containing the report of the National Electric Light Association's Convention contained more than 150,000 words. It may give a clearer idea of the magnitude of these figures to say that this one issue would have made in itself a volume larger than Kapp's "Electrical Transmission of Energy," the size of which is familiar to most electricians. The paper, however, comes out every week. The great mass of information contained in the paper during the year relates to every conceivable electrical topic, and it is the endeavor, so far as possible, to cover the modern science of electricity in both its theoretical and practical aspects. How far THE ELECTRICAL WORLD has been successful in this can safely be left to the readers to judge, attention being merely called to some of the more prominent articles that have appeared, by way of recording the electrical advance of the period.

**In the Field of Electric Lighting.**—The paper this year has been especially rich in elaborate illustrations and descriptions of important central stations. Among these we may notice the great station at Brooklyn, Vol. XV, page 221; the plants at Jersey City, XV, 343; Pittsburgh, XV, 57; Union Hill, XV, 433; Woonsocket, R. I., XVI, 23; Albany, XVI, 164; Spokane Falls, XVI, 181; Boston, XVI, 281; Jenkintown, Pa., XVI, 314, and numerous others. Aside from these central stations many important isolated plants have been illustrated, giving a clear idea of the method of lighting by electricity a great building or steamship. Among these we may mention the beautiful installations in this city at the Progress Club, XVI, 83; the Imperial Hotel, XVI, 238; the Plaza Hotel, XVI, 331; and, besides these, the elaborate accounts of the electric lighting of the new White Star Steamship "Majestic," XV, 296: the electrical appliances of the Sound steamers "Connecticut," XVI, 66; and "Plymouth," XVI, 328. These are only a part of the electrical installations of which we have published this year detailed descriptions. To any one intending to establish an electrical plant these cannot fail to be of both interest and value as showing the result of the best modern practice. THE ELECTRICAL WORLD gave the first published account of the practical



DR. LOUIS DUNCAN.
Vol. XVI, Page 236.

application of the new arc light system of the Westinghouse Company, XV, 220, and it has followed every improvement that has been made in electric lighting methods and apparatus. Dealing with the more theoretical part of electric lighting, we may notice espe-

cially the valuable paper of Mr. Marks, XV, 364, treating of arc light carbons, their structure, life and adaptation to various sorts of service; the interesting practical papers of Messrs. Law and Lockwood, read at the Kansas City Convention of the Electric Light Association, XV, 151; the splendid investigation of alternating current apparatus by Dr. Louis Duncan, XV, 242; the very complete study of the problems of electrical distribution by Herzog and Stark, XV, 300; XVI, 128; the interesting account of the construction of commercial regulators by Mr. Herrick, XV, 239; the description of modern electric meters by Robert Shand, XVI, 368, and numerous others. Of new machines and systems we have given numberless details. Among these we may mention the recently completed Stanley arc light machine, XV, 44; the remarkable Reignier-Bary dynamo, XV, 238; the extraordinary Thomson alternator, XVI, 68, and many others. It has been the endeavor of THE ELECTRICAL WORLD in covering this important field to place before its readers not only the valuable papers read before the different societies but also accounts of original investigations prepared especially for the paper, many of which will be found in the list we have just presented. At the same time it has aimed to keep its readers informed of the important electrical work that has been done in other countries. It is the intention of the paper to be what its name implies, and to put before its readers the theory and practice of electrical engineering as exhibited in every civilized country. To this end articles are drawn freely from foreign sources. Among the most important of these foreign contributions during 1890, so far as electric lighting is concerned, have been Mr. Esson's brilliant paper on the designing of dynamos and motors, XV, 213, 226, 243, 258; Mr. A. T. Snell's discussion of two-pole machines, XV, 237; and the very elaborate and complete account of practical alternating current installations from the pen of Dr. J. A. Fleming, contributed to the London ELECTRICIAN and republished in America by THE ELECTRICAL WORLD only, XVI, 58, 73, 85, 104, 122, 157, 170, 303, 315, 335, 351, 391, and still running; a paper by M. Rechniewski on the best speed for dynamos, XVI., 189, and others to be found in almost every issue.

**The Stationary Motor Business** has grown during the year to an enormous extent. Some important new forms have appeared and many interesting figures have been obtained from the experience of the past months. The Duncan multipolar motor—in some respects the most remarkable electrical invention of the year—was first described in THE ELECTRICAL WORLD, XV, 335. A full account of the recent successful experiments with alternating motors abroad will be found in our columns, XV, 223, 270; and the subject of motor testing has been handled in a masterly manner by Prof. F. B. Crocker, well known by his success in this field, XV, 114. To-day the stationary motors in use amount to not less than 20,000 horse power, and every month brings in reports of increased orders, and the installations of new plants for the furnishing of power. If we were to select any one line in which progress had been especially marked during the past year, we should instinctively mention the electric railroad, and it is in this department that THE ELECTRICAL WORLD can lay claim to having covered the field with a completeness unknown to any other journal at home or abroad. The growth in the number of electric roads has been prodigious, so that at the time of writing there are more than 250 in operation in various cities and towns throughout the United States, running on more than 2,000 miles of track, and operating nearly 4,000 motor cars of an aggregate horse-power of not less than 175,000. The papers of the year on this topic have been published in THE ELECTRICAL WORLD, and many of them there alone, like the valuable researches of Mr. Hale, XV, 330, and Mr. Hulett, XVI, 103. The former of these calls attention to the class of facts that must be considered to secure efficient working of electric roads. It attacks for the first time the question of motor gearing from the standpoint of actual experiment, and its treatment of the mechanical and electrical details of the problem are particularly well worth studying. The latter paper is a complete test of the power station, going in detail into the efficiency that is and can be obtained, and exemplifying the first application of self-registering instruments to the study of the extraordinary variations of power found on railway lines. Beside these striking original papers, are five that bear especially on the extension of the electric railway into being something more than an improved method of running street cars. Of these we have the elaborate discussion by Mr. Sprague, read before the Kansas City Electric Light Convention, XV, 147; the general discussion of the possibilities of the motor in long-distance railway work by Dr. Bell, XV, 210; the beautiful investigation of the conditions that affect the possibility of very high speed electric traction, by Mr. O. T. Crosby, XV, 346; the very complete examination of this whole topic of electric railways on a grand scale by the same author, read before the American Institute of Electrical Engineers, XV, 361; and, finally, like an echo of triumph from these earlier suggestions, comes the account of the first electric suburban road on anything like a railway scale, XVI, 385.

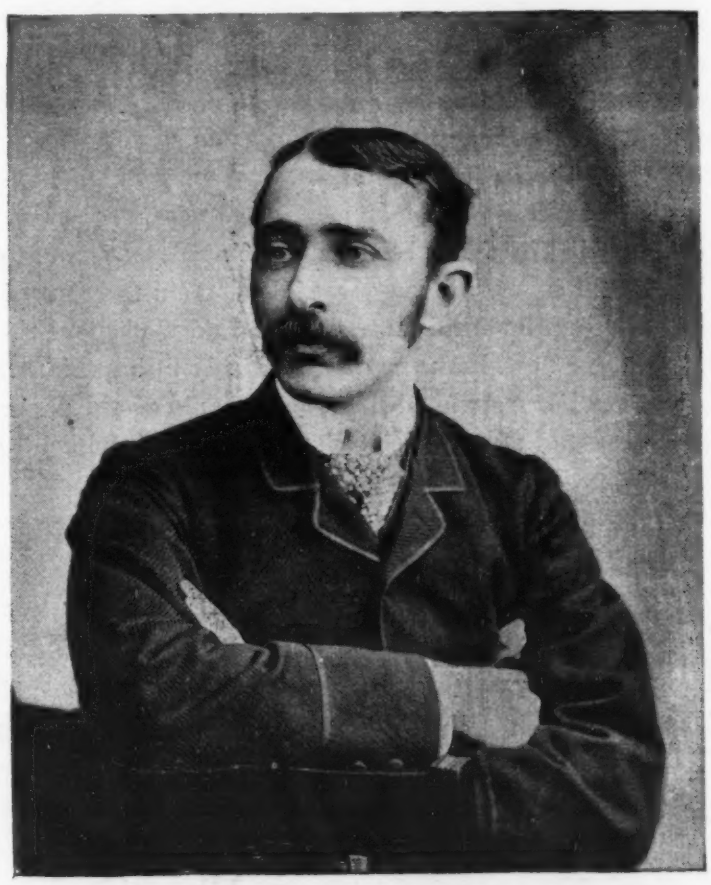
**Storage Battery Traction** has been growing rapidly and has attracted more and more attention as the demands of city service have impressed the necessity for it on the public mind. This topic has received thorough discussion in the columns of THE ELECTRICAL WORLD at the hands of Mr. Reckenzaun, XV, 388. Although his results were first given to the public in England, his data were obtained from experiments made in this country. Aside from these we should certainly mention the very exhaustive study of the conditions of economy in storage battery traction by M. Gadot, translated especially for THE ELECTRICAL WORLD, XV, 321, 351, 374, 394, 408, 423. The able and striking papers by Professor Ayrton and his associates on The Working Efficiency of Secondary Cells, XVI, 89, 107, 124, 158, and on The Chemistry of Secondary Cells, XVI, 423, are a most important addition to our knowledge of the actual efficiency of accumulators.

OSCAR T. CROSBY.

Vol. XV, Page 356.

**The Systems of Electric Traction** have been increased in number during the year, prominent among the additions being the one exploited by the Westinghouse Company. The first published account of this system, with a view of the first road operated by it, may be found in THE ELECTRICAL WORLD for September 20th, XVI, 197, and fuller details of the motor and method of regulation in a later issue, XVI, 277. The Short System has been installing some important plants. The construction of the Short motor was described in the special issue of THE ELECTRICAL WORLD, distributed at the Buffalo Convention of the American Street Railway Association, XVI, 280. For the purpose of laying before this convention a full account of modern electric railway results, THE ELECTRICAL WORLD sent out an elaborate list of questions to all

the street railway companies in the United States. These interrogatories dealt with the details of service and the results obtained. They included the cost of power, cost of repairs, effects of electric traction in stimulating travel, life of running gear, experiments on grades and with single and double motors, and many other points bearing directly upon the commercial success of electric street railway systems. Replies were received from a large proportion of the roads addressed, and from the data obtained was compiled a summary of results, laying before the electrical public a vast amount of information, never before published, regarding the practical side of electric traction. It was found, for example, that from an average of many roads the mean daily run of an electric car is almost exactly one hundred miles; that the cost of power is on an average within a very small fraction of two cents per car mile; that the cost of repairs amounts—taking the general mean of all reports—to a little less than one-fifth the total operating expenses, but is perceptibly less on some of the later roads. In fact this one article contains, perhaps, more important information for electric street railway men than any other single article published during the year, XVI, 274. The American Street Railway Convention at Buffalo was reported in full, XVI, 295, 299, and additional details as to the Westinghouse Electric Railway were obtained from their exhibit at the convention, XVI,



PROF. JOHN AMBROSE FLEMING, M.A., D.Sc.
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294. The latest new system of street car propulsion is probably the Wenstrom, involving as it does some very radical changes from existing practice. The low speed of the motor, the absence of the intermediate gear, and the flexible method of connection between driving shaft and axle, so as to allow of varying speed, make it a noteworthy innovation, and so interesting a one that considerable space was taken for an elaborate description of the system, XVI, 293.

**Somewhat Analogous to Electric Railway Work** is that particular branch of motor service which deals with mining. Both for traction in mining, and for the operation of mining machines, the electric motor has made remarkable progress during the year. Many of the inventors seem to have turned their energies towards devising practical electric drills and coal cutters, XV, 77, 225, 272, 349, 408. And the growing use of such apparatus is evidence that its valuable qualities are appreciated. The mining locomotive, too, has taken its place in the equipment of more than one large establishment, XV, 12, 77, and it is interesting to note that at one important mine, at Scranton, Pa., such a locomotive is in daily use to draw loads of over a hundred tons, which it handles smoothly and easily at the rate of as high as six miles an hour. In several of the Ohio mines also, electricity has been extensively adopted, and a most interesting account of its various applications there was given during the month of September, XVI, 198. Still another fine mining installation is the very interesting one at the Willock mine, equipped with alternating current motors, XVI, 115.

**Looking back from Recent Developments of Electrical Industry to Telegraphy,** its oldest branch, we find nothing exceedingly new or of great theoretical importance, although there has been a steady improvement in apparatus and methods. At the last telegraphers' fast-sending tournament, some months ago, all previous records of rapid work with ordinary Morse instruments were broken by the phenomenal sending of Mr. Pollock, at the rate of fifty-two words a minute, XV, 270. Several other splendid records were made at the same time. Throughout the telegraphic world there has been a general growth of lines and steady business without any striking innovations. Two instruments, however, are especially worthy of note as embodying novel and valuable features, one the remarkable page-printing telegraph, which has been notably improved during the present year, XV, 287; the other Patten's method of synchronous telegraphy, which has as yet hardly entered upon its practical career. The tendency on the part of large telegraph offices to discourage the use of batteries and employ specially-wound dynamos for generating currents has shown itself in the establishment and operation of several excellent plants, XV, 173; 253, XVI, 313. The dynamo for this purpose is an important improvement in telegraphic methods, inasmuch as there is an enormous saving of care and expense by its use, particularly as these special dynamos are usually operated by electric motors. The Postmaster General's scheme—XV, 329—for a limited postal telegraph service has sunk into well-deserved oblivion, and probably will not appear for some time to come. Two interesting telegraphic communications from England, illustrated, by Messrs. Melhuish, XV, 315, and Barker, XVI, 357, deal respectively with various clever devices for facilitating submarine communications, and the practical use of a suspended coil galvanometer for cable work in place of the ordinary Thomson instrument.

**The Telephone** has had a career during the past year quite similar in its uneventfulness to that of the telegraph. One of the most interesting additions to telephonic resources is the successful series of experiments of duplex telephony recently tried on one of the Canadian lines, XV, 312.

**Among Miscellaneous Electrical Inventions** and Improvements may be mentioned the Fiske range finder, which has been subjected to a number of exhaustive sea trials and has acquitted itself in a manner that speaks well for its probable usefulness in war, XV, 93, 178. In the department of instruments there have been improvements in forms of apparatus, many of which are of no little interest, but their number is too great to receive detailed reference here. Suffice it to say that descriptions of all the more important improvements may be found in the columns of THE ELECTRICAL WORLD.

**Passing from Practical Applications of Electricity to Subjects of more Theoretical Interest,** some notable advances in theory have been made during the year. Perhaps the most remarkable single paper has been that exceedingly brilliant and searching investigation into the nature of magnetism read by Professor J. A. Ewing before the British Association for the Advancement of Science. It is by all odds the most important recent addition to magnetic theory, and deserves the attentive study of every electrician, practical and theoretical, XVI, 241, 262. The magnificent researches of Hertz, which have done so much to revolutionize our views of electrical phenomena, have borne fruit in the elaborate paper by that investigator on the electro dynamics of stationary bodies, putting in as clear form as the abstruse nature of the subject admits the latest additions to electrical theory. A translation of his paper has recently been published in THE ELECTRICAL WORLD, XVI, 285, 302, 334, 350. Another most interesting theoretical paper is that on the magnetic properties of alloys of nickel and iron, by Dr. John Hopkinson, who has just received the medal of the Royal Society for his splendid work in magnetic theory, XVI, 172. The 1890 meeting of the British

Association for the Advancement of Science was reported in these columns at great length. Two brilliant papers by Sir William Thomson on the peculiarities of alternating current transmission were a feature of the meeting. They dealt particularly with those cases in which special forms of conductor have to be constructed to avoid the injurious effects of self-induction, XVI, 224, 225. It may be interesting to add that a curious illustration of the principles laid down in these papers was recently found in one of the New York electric light systems. An excellent *resumé* of the work that has been done in determining the absolute unit of resistance was given at this same important meeting by Professor Glazebrook. It gives a very instructive account of the methods and

PROF W. E. AYRTON.

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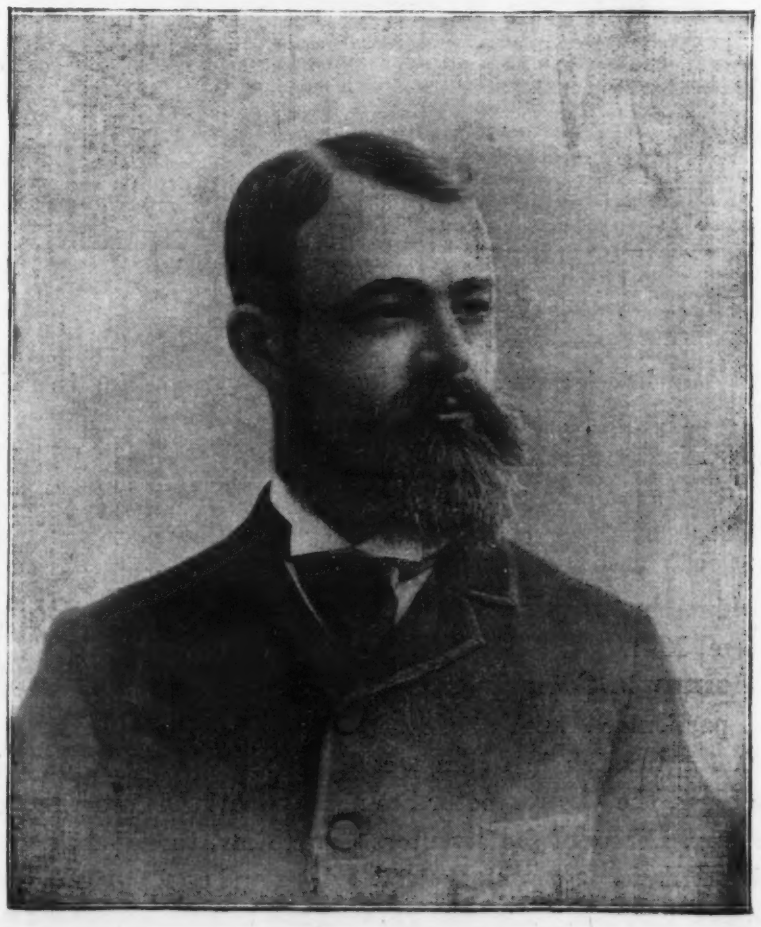
results of the determination of absolute resistance, XVI, 261. The modern theory of electricity or electrical action, as it has been developed at the hands of Poynting, Lodge, Hertz and others, has been admirably reviewed in the columns of THE ELECTRICAL WORLD by Professor Arthur L. Kimball, whose paper gives a very clear popular account of the latest ideas as to the nature and characteristics of electricity and electro magnetic radiation, XVI, 332, 348. Of a character somewhat less electrical than these, but no less interesting to those of our readers who are in the truest sense electrical engineers, is Professor Thurston's discussion of the possibilities of the modern steam engine, XVI, 84. A particular branch of electrical study that has received more than usual attention recently is the physiological effect of the electrical current. Two papers on this subject deserve special mention. One of these is from England, by Messrs. Laurence and Harries, and deals with the relative effect of direct and alternating currents; but more important yet, perhaps, by reason of singularly careful scientific work, is the contribution by Dr. Tatum, XV, 314, to our knowledge of this occult subject. His experiments are particularly important, as showing something of the mechanism of the action of fatal electric currents, and pointing out the probable marked differences in physiological action between continuous and alternating currents, a subject which had been heretofore treated in a rather unscientific manner. In speaking of this subject, it may mention that THE ELECTRICAL WORLD was the only technical paper that gave a full and unbiased account of the execution of Kemmler. The representative of THE WORLD was, we believe, the only member of the press who was granted access to the apparatus and permission to make the necessary sketches before the execution. XVI, 99, 105.

**Among Electrical Articles of a Particularly Noteworthy Character** we must mention Prof. Silvanus P. Thompson's Cantor Lectures on the Electromagnet. They constitute by far the most important contribution to this very practical subject that has yet appeared. By special arrangement these lectures, revised by the author's own hand, were published simultaneously abroad and in THE ELECTRICAL WORLD. They have continued through the latter part of the year, beginning with the issue of the 30th of August, XVI, 155, and have just been completed. The lectures have now been issued in book form by the author's express permission, and with his revision. It is confidently believed that this is *the* electrical book of the year, so far as practical applications of electrical theory are concerned.

**This Record of the Year's Progress,** it will be seen, is a notable one, but great as it is it is only a promise of what is to be done in the field of electrical industry. It has been the desire of THE ELECTRICAL WORLD to present the whole subject in as full a manner as possible to its readers, and a reference to the files of the journal will give a better idea of how this has been done than the few items to which attention can here be called. Several new features have been introduced into THE ELECTRICAL WORLD during the year, that have met the approval of the readers. Of these we may mention the illustrations, more elaborate than are attempted in any other electrical journal; the description of the chief schools of electrical engineering; the regular publication of lighting tables for the use of central station managers; an elaborate account of the electrical stock market published every week; and, finally, a weekly cable dispatch from London giving the very latest electrical news from foreign lands. If THE WORLD has failed to give all the electrical work that might interest its readers, we may assure them that it is only because the enormous amount of electrical material has made very careful selection necessary in order to bring the paper within finite bounds, and we believe that what omissions there have been are comparatively unimportant.

This gives but a slight idea of the contents of the paper and of its great value not only to electricians but to the intelligent general reader as well. The subscription price is a merely nominal amount, $3 for 52 numbers. The offices are at 167 to 177 Times Building, New York, and it is the largest electrical journal in the world.



PROF. EDWARD L. NICHOLS.

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DURING 1891 THE ELECTRICAL WORLD HOPES TO DO ITS WORK MORE COMPLETELY, MORE THOROUGHLY THAN EVER, AND IT WILL CONTINUE TO ENDEAVOR TO BE WHAT ITS NAME SHOULD INDICATE —A COSMOPOLITAN JOURNAL OF ELECTRICAL THEORY AND PRACTICE.

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# THE ELECTRICAL WORLD

A Weekly Review of Electrical Progress

VOL. XVI.—No. 26.

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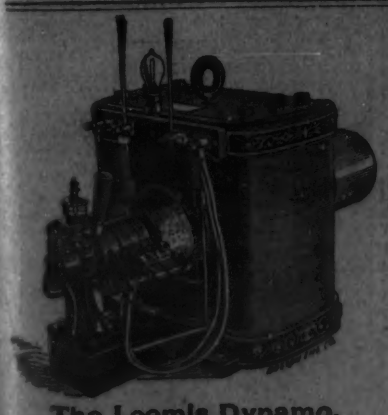

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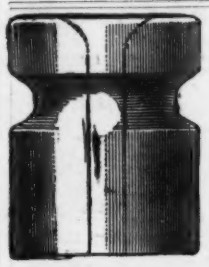

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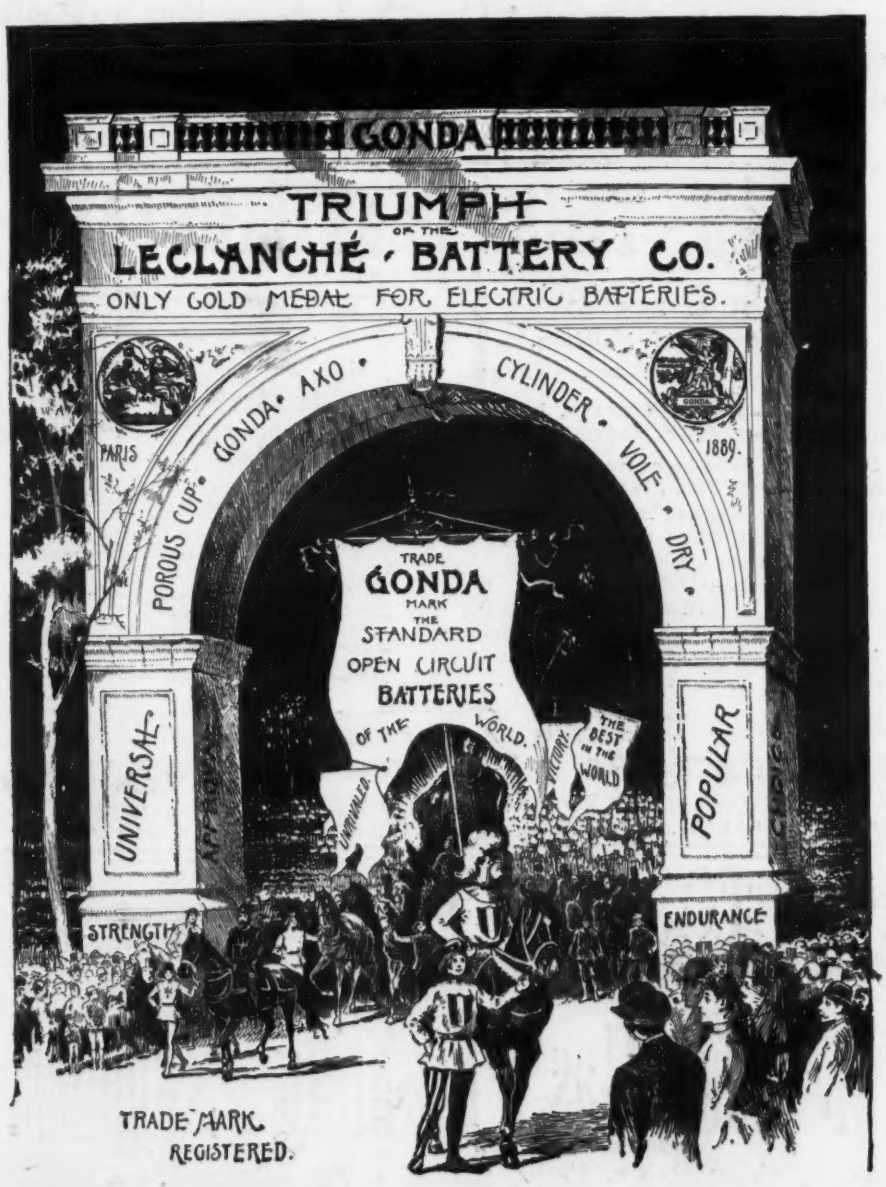


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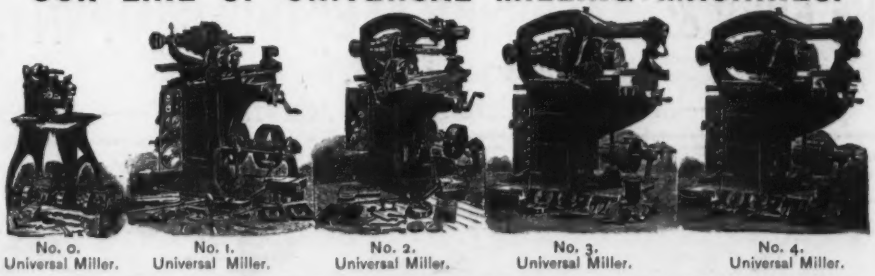

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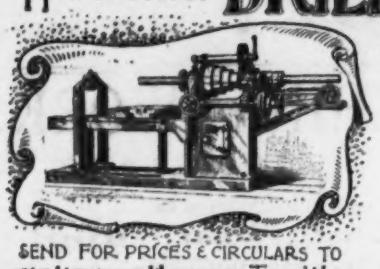

Great Power.

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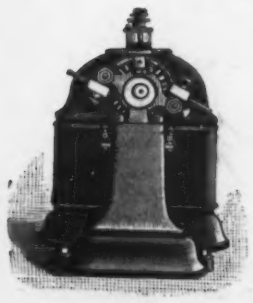

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WE OFFER THE ABOVE BATTERY AS

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IN THE MARKET FOR

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In short, for all kinds of Open-Circuit Work, and it will be found to be the superior of all Batteries of its kind in Simplicity, Cleanliness, Economy, Safety, Durability and Cheapness.

This "Telephone" Battery is provided with our

PATENTED SEALING DEVICE,

which keeps the solution clean and prevents its loss by evaporation or spilling. It is the only Portable Battery, and can be safely transported with all its contents intact.

**Special Inducements to Large Buyers.**

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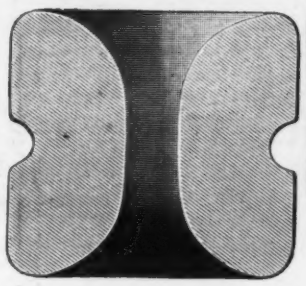
Ever Produced!!



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**300,000 Pieces ordered in one week.**

Stands More Heat than Anything. Stands Exposure to the Weather.

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GENTS: We have been running your Leather Link Belts on 12 of our dynamos and engines for the past eight months. They have given us entire satisfaction. I believe they are the best belts made for the transmission of power.

Yours respectfully,
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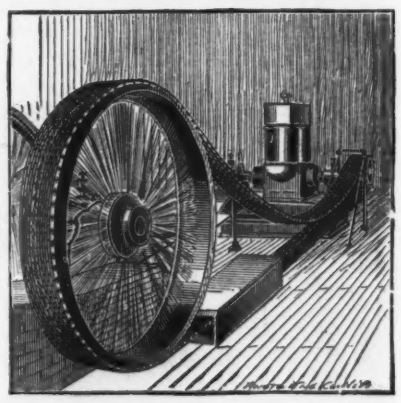
N. B.—These belts are 15 inches wide and transmit power for 10,000 incandescent lights.



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46 and 48 Ferry St. and 72 Cliff St., New York.

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# IMPORTANT INFORMATION TO THE TRADE.

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We carry a large stock of House Supplies, including Annunciators, Speaking Tubes, Bells, Batteries, Push Buttons, etc.
We are the Eastern Agents for J. H. Bunnell & Co., of New York, and
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OUR PRICES ARE ALWAYS THE LOWEST.

"MAKE NO MISTAKE," BUT CORRESPOND WITH US BEFORE YOU BUY.

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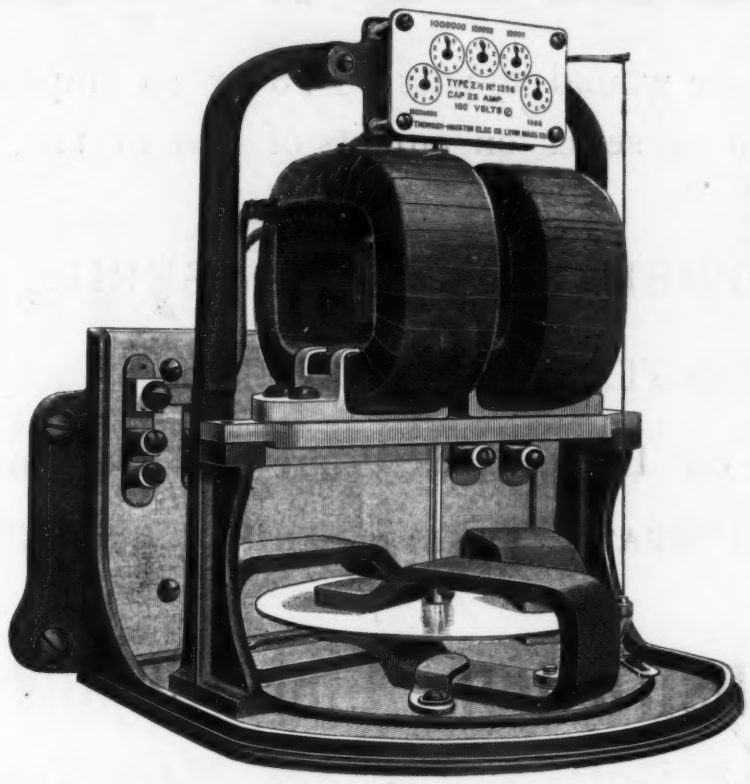
# WATT-METER,

**SIMPLE IN DESIGN AND CONSTRUCTION.**



Has no Air Fan.

Has Nothing to Weigh.

Easy to Install.

Direct Reading.

**Low Speed and Consequent Durability.**

**ACCURATE ON ONE LAMP OR FULL LOAD.**

HIGH EFFICIENCY.

ADAPTED FOR CONTINUOUS OR ALTERNATING CURRENTS.

CAN BE USED ON ANY SYSTEM.

## FOR LIGHTING INSTALLATIONS

**10, 25, 50, 100, 150 AMPERE CAPACITY, FOR 50, 75 and 100 VOLT CIRCUITS.**

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**25, 50, 100 AND 150 AMPERE CAPACITY, FOR 250 AND 500 VOLT CIRCUITS.**

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## THE ONLY COMMERCIAL ARC LAMP FOR

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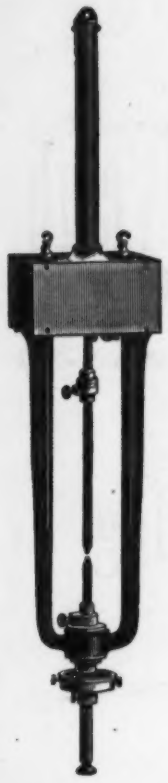

These lamps are wound to pass 6½, 8 or 10 amperes, as desired, and when burning two in series on circuits of 100 to 120 volts give a clear, steady light.

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We guarantee our Lamps, Electrically and Mechanically.

PLEASE STATE SYSTEM AND VOLTAGE USED.

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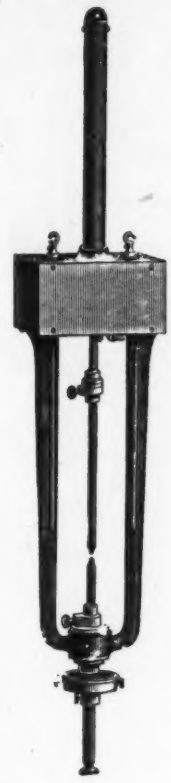

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Electromotive Force, 1.55 Volts. **For Open Circuit Work.** Current, 1 to 15 amperes.

The only battery sold semi-charged. Does not work until wanted. Only a small quantity of pure water necessary to charge it. All users endorse it.

**NEAT.**

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**Made in all shapes and sizes.**

Recuperates Quicker and Oftener than any other. For Housework, Hotels, Gas Lighting and Medical Use it has no equal.

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**Afford the Only Reliable and Efficient Means for**

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**All Other Devices are Crude, Expensive, and Unsatisfactory.**

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Founded by Samuel S White in 1844.

JAMES W WHITE, President. J. CLARENCE WHITE, Secretary
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Gentlemen:

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Yours truly,

The S. S. White Dental Mfg. Co.

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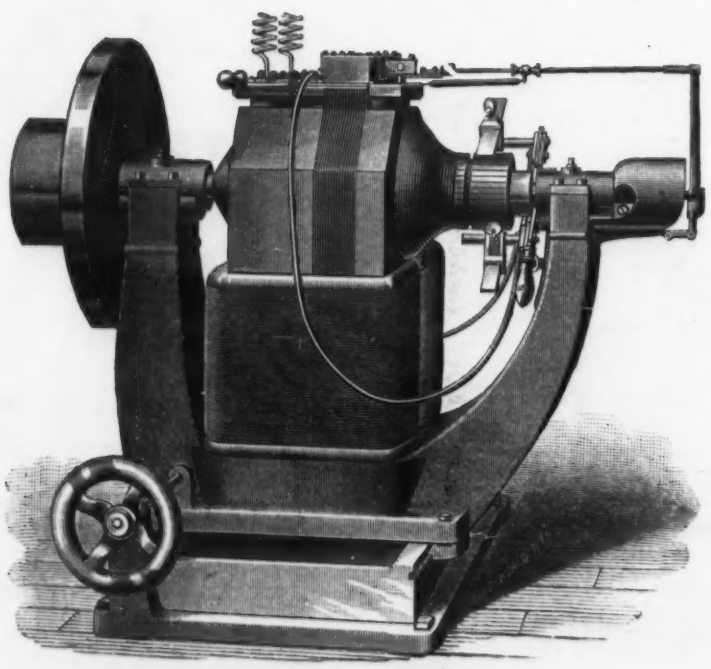
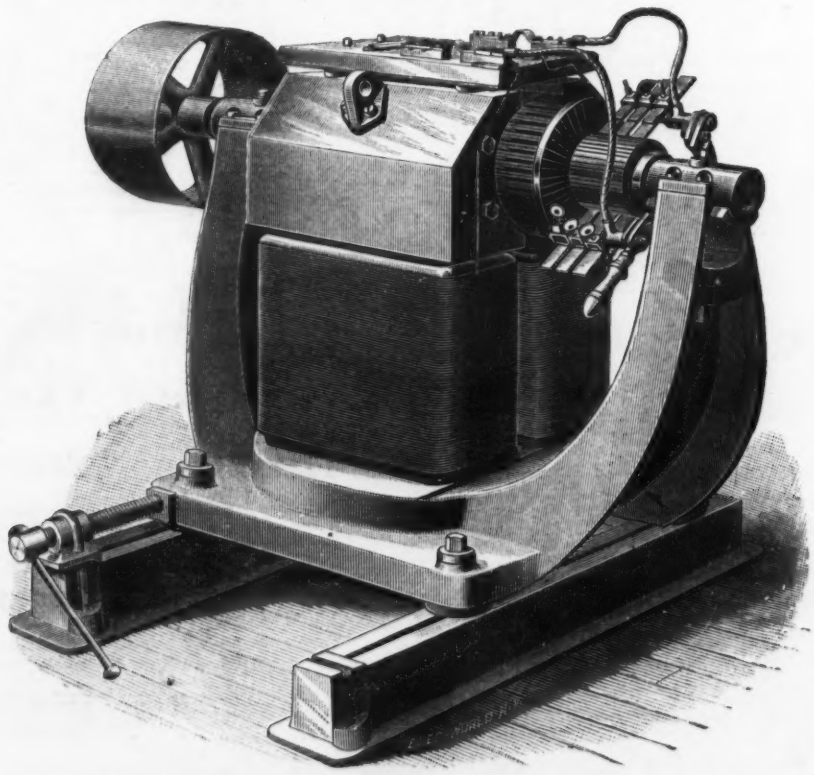
HIGHLY EFFICIENT AND ECONOMICAL. CONSTANT SPEED UNDER ALL LOADS.





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**The A. B. C.**

## INCANDESCENT LAMP!

FIRST IN LIFE,
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MADE TO FIT ANY SOCKET.

## GENERAL ELECTRICAL SUPPLIES.

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—FOR—

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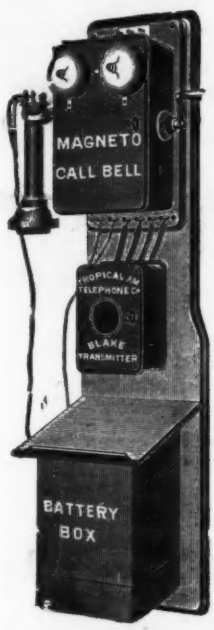


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*SOLE AUTHORIZED EXPORTERS TO*

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**American Bell Telephones, Blake Transmitters and Magnetos.**
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**A new Telephone, set for export, just out, price $15.**
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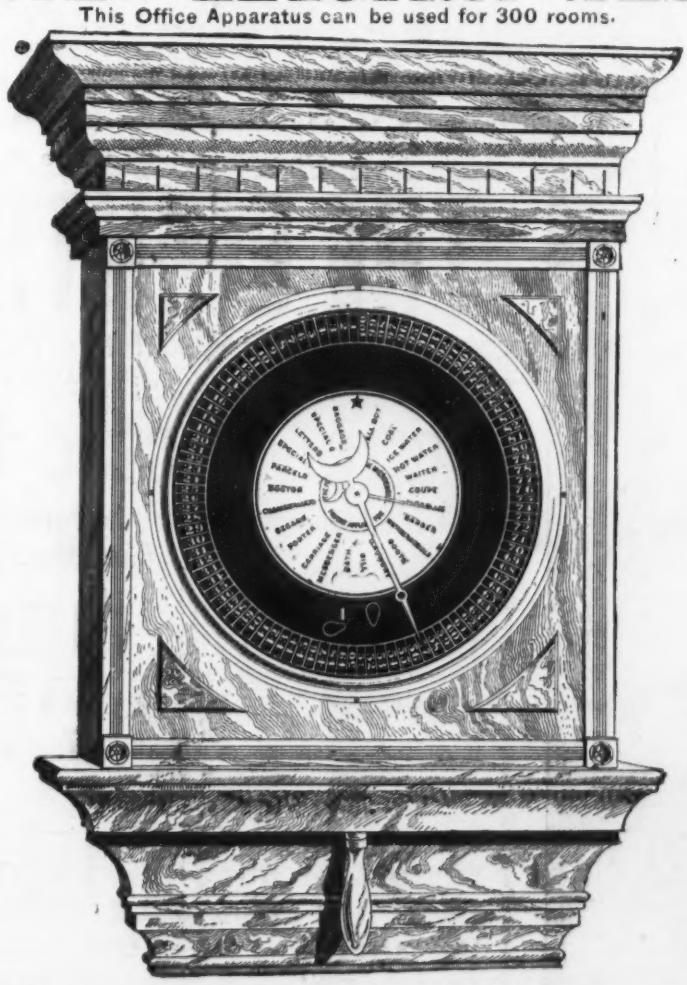
This Office Apparatus can be used for 300 rooms.

This system can be introduced into any Hotel now equipped with ordinary Gravity or Needle Annunciators, and ordinary push button in rooms. No additional wires required. Remove old Annunciator and connect the Porter Messenger in its place. Remove wood push button and use our room box in its place. Electricians should recommend this complete and simple system to all architects and Hotel Proprietors.



It is not necessary for us to state the merits of this apparatus. The one fact that it is in operation in the largest hotel in the country, The Auditorium, of Chicago, and giving perfect satisfaction, is sufficient to recommend it to every new hotel.

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The above system has been successfully installed in the following hotels:
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OUR

**Grimshaw White Core Wire**

NOW BEING USED THROUGHOUT

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WASHINGTON, D. C.

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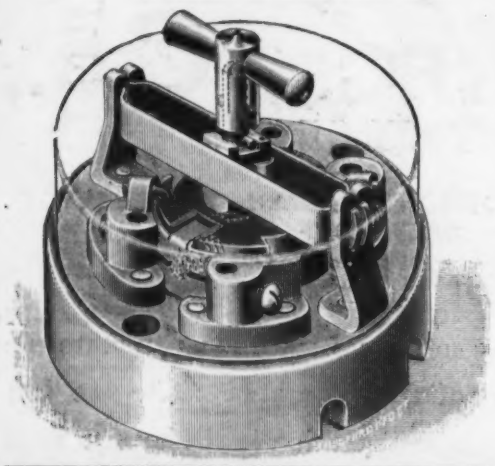

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## THE PERKINS INCANDESCENT SWITCHES

MADE WITH POCRELAIN BASES ONLY

No. 1. Capacity up to 10 amperes, single pole. No. 4. Capacity up to 40 amperes, double pole.
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**Rated with Continuous Current. With alternating current their capacity is increased 50 per cent.**
**All parts made to gauge and interchangeable. Every Switch guaranteed.**

Correspondence Solicited.

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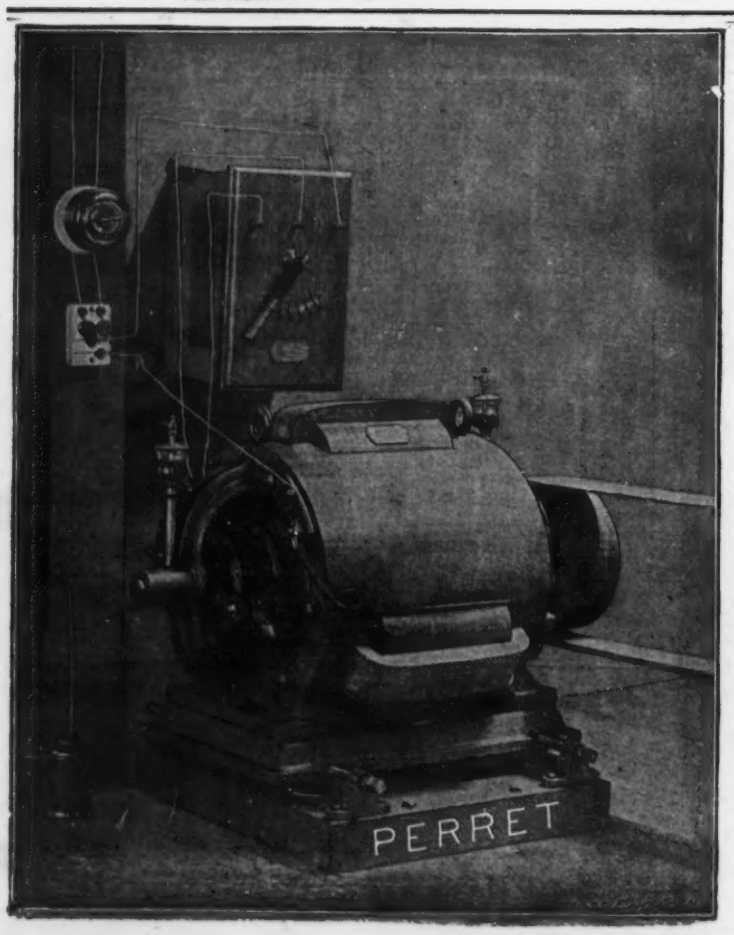


20 Horse-Power Perret Motor. Speed, 550. Weight, 13,00 lbs.

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Automatically Regulated, Unexcelled in Simplicity and Durability.

THE ONLY MACHINES HAVING

## Laminated Field Magnets of Softest Charcoal Iron.

**HIGH EFFICIENCY.**
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Motors of all Sizes for all Purposes
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Dynamos for Isolated Electric Lighting Plants.
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# TRANSFORMER SYSTEM OF INCANDESCENT LIGHTING.

**It will pay you to throw out your present Transformers and substitute our make.**

They are the most EFFICIENT (95.2 per cent.)
They are absolutely SAFE.
Their regulation is practically PERFECT.

NO MORE ACCIDENTS FROM GROUNDED CIRCUITS.

NO MORE BURNT FINGERS OR MELTED SCREW-DRIVERS.

TRANSFORMER ON POLE, SHOWING NATIONAL SAFETY FUSE BOX.

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**Central Station Equipments**
—FOR—
LIGHT OR POWER DISTRIBUTION.

OUR APPARATUS
IS OF THE
***HIGHEST EFFICIENCY,***
MECHANICALLY AND ELECTRICALLY.
We Guarantee its operation and
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—FOR—
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Complete Electric Light and Railway Installations.

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Remember—We manufactured that beautiful belt, 140 by 48, double leather, for the Brush Electric Light Company, Cincinnati, that you saw at the Convention.

Office and Factory, - - - 332 to 336 Washington Street,

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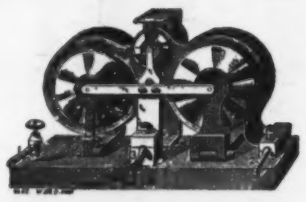

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## Electric Protector and Lightning Arrester.

LIVE AGENTS CAN MAKE MONEY

Introducing these instruments. Sells at sight. Liberal commission. Several thousand in use giving universal satisfaction. The best of testimonials. Every Electrical Supply House having traveling salesmen would advance their interests by investigating the merits of this protector.

For particulars address C. E. SANFORD, Lessee.

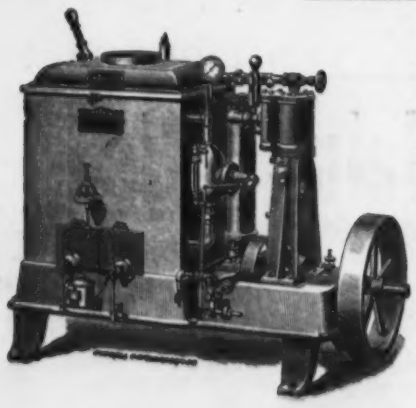
NATIONAL ELECTRIC PROTECTOR COMPANY, 18 Broadway, New York.

# THE SHIPMAN AUTOMATIC STEAM ENGINE

One, Two, Four, Six and Eight Horse Power,

## STATIONARY AND MARINE.

The automatic action of fuel and water supply, as well as **Uniformity of Speed, Steady Steam Pressure, Regular Supply and Even Level of Water in Boiler,** make "The Shipman" the most desirable power for small **Isolated Electric Plants** on the market.



BOSTON, Mass., Jan. 22, 1889.

*Shipman Engine Company:*

GENTLEMEN: In reply to yours of 21st inst., inquiring as to how we like the Shipman Engine for use in connection with our dynamos, we may say that during our experience of some months we have found that your 2 h. p. engine gave one of the most satisfactory sources of power for operating a 20-light B dynamo that it has ever been our good fortune to come across. The power was steady, very regular as to speed, and the engine seemed thoroughly automatic, conforming to changes of load quickly and accurately. Its ease of operation, coupled with simplicity of mechanism and the minimum expense sustained for fuel, lead us to consider it a very valuable source of power for small installations, and one which we can most cordially recommend.

Yours respectfully,
FRED M. KIMBALL & CO.

SEND FOR CATALOGUE. MENTION THIS PAPER.

SHIPMAN ENGINE CO.,
200 Summer St., Boston.

# The Beacon Vacuum Pump and Electrical Co.

MANUFACTURERS OF THE

## BEACON VACUUM PUMP,

(BERRENBERG PATENT.)

FOR EXHAUSTING INCANDESCENT LAMPS.

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ABSOLUTELY FIREPROOF.

Removable Coverings FOR STEAM PIPES.

*Manufacturers of*

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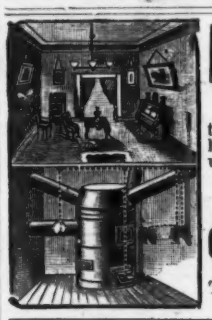

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Save coal, save doctors' bills, save labor.

Automatic, simple and durable. Insure UNIFORM temperature throughout the house. No heater complete without it. Can be applied to ANY KIND OF heating apparatus. Try one and be convinced. If not sold in your town, write us for illustrated circular and prices.

**Beware of Cheap Electric Infringing Apparatus.**

Agents wanted and correspondence solicited.

*See our advertisement in January "Century.*

## CONSOLIDATED TEMPERATURE CONTROLLING COMPANY,

645 Temple Court, Minneapolis, Minn.

The New England Fire and Heat Regulator Co., 65 Federal street, corner Franklin, Boston, sole agents for New England.

# Massachusetts Electrical Engineering Co.,

4 Post Office Square, Boston, Mass.

STONE & WEBSTER, Managers.

## ENGINEERING DEPARTMENT.

The position which this company occupies in respect to electrical matters is similar to that of the architect to the design and erection of buildings.

If electrical apparatus is to be designed, constructed or installed, our method is first to consider its intended uses and location; then to submit plans and specifications to the intending purchasers for approval, and to the various electrical and mechanical companies for contracts and bids; to personally supervise the work of installation; and finally to test the complete apparatus, both electrically and mechanically, in order to insure the fulfilment of the conditions of the contract.

The advantages to the purchaser of unprejudiced and competent advice in the selection of apparatus, expert superintendence during construction, and of test at completion, are points which we especially commend to the attention of business men.

The

# Remington Standard Typewriter.

For Fifteen Years the Standard and to-day the most perfect development of the writing-machine, embodying the latest and highest improvements of inventive and mechanical skill. We add to the Remington every improvement that study and capital can secure.

*Wyckoff, Seamans & Benedict,*

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# LONG DISTANCE POWER TRANSMISSION.

## WATER POWERS MADE PROFITABLE.
## STEAM PLANTS SUPERSEDED.

240 H. P. furnished at a point seven miles from Generator over a circuit of No. 0 B. & S. Wire; loss 15 per cent.

SEND US DATA AND WE WILL FURNISH FULL ESTIMATES OF

## ELECTRICAL APPARATUS.

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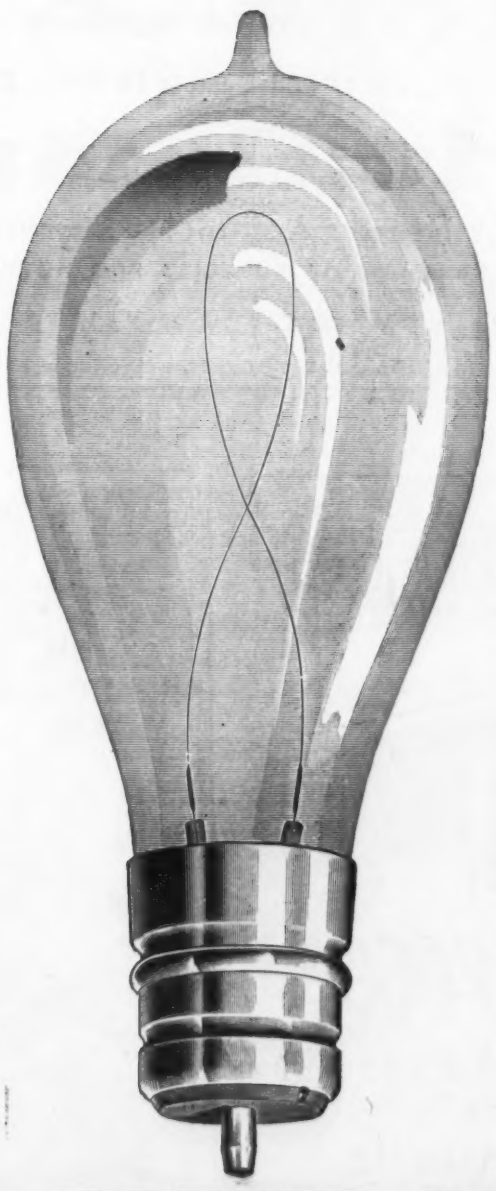
# INCANDESCENT LAMPS.

To Fit any Socket.

Excelling all others in Life, Maintenance of Candle Power and Efficiency.



From 8 c. p. to 150 c. p., and any Voltage.

Even Diffusion of Light by Twisted Filament.

## THE BEST IS

General Electrical Supplies of Superior Design and Finish.

## THE CHEAPEST.

Send for our Catalogue of August 1st., '90.

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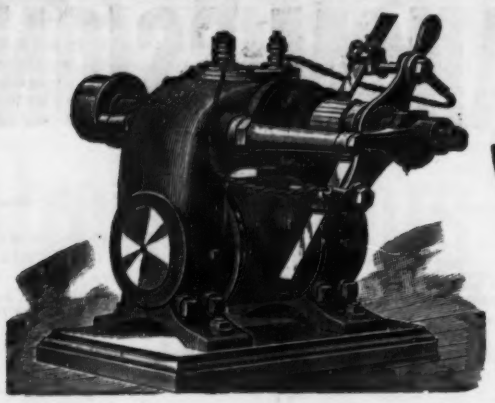
620 ATLANTIC AVENUE, BOSTON, MASS.
217 LA SALLE ST., CHICAGO, ILL.



OUR MOTORS ARE AUTOMATIC, HIGHLY EFFICIENT, BEAUTIFUL RELIABLE DURABLE

# JENNEY

FOR ARC AND INCANDESCENT CIRCUITS. SELF-OILING BEARINGS. 1 TO 50 H.P.

## ELECTRIC MOTOR CO.

Every MOTOR Guaranteed.

SEND FOR CATALOGUE.

**Office: 224 South Illinois Street, Indianapolis, Ind.**

LIST OF DYNAMOS IN STOCK.

| Designation of machine. | No. lights 2,000 c. p. 10 amp. X | No. lights 1,60 c. p. 8 amp. Y | No. lights 1,200 c. p. 6 amp. Z | No. lights 800 c. p. 4 amp. | Horse power at pulley of dynamo. | Width of single belt in inches. | Belt speed required. | Weight of dynamo. |
|---|---|---|---|---|---|---|---|---|
| .... | ..... | ..... | ..... | ..... | ..... | ..... | | 800 |
| C | ..... | ..... | ..... | ..... | ..... | ..... | | 800 |
| C | 8 | ..... | ..... | ..... | 6.5 | 1¼ | | 530 |
| C | ..... | 10 | ..... | ..... | 6.3 | 1¼ | | 530 |
| C | ..... | ..... | ..... | 25 | 8.0 | 2 | | 530 |
| E | 16 | ..... | ..... | ..... | 12.0 | 2½ | | 780 |
| E | ..... | 20 | ..... | ..... | 12.5 | 2½ | | 780 |
| E | ..... | ..... | 26 | ..... | 13.0 | 2⅝ | | 780 |
| E | 20 | ..... | ..... | ..... | 15.0 | 3 | | 990 |
| F | ..... | 25 | ..... | ..... | 15.6 | 3 | 5,000 Feet per minute. | 990 |
| F | ..... | ..... | 32 | ..... | 15.0 | 3 | | 990 |
| F | ..... | ..... | ..... | 50 | 16.0 | 3 | | 990 |
| G | 28 | ..... | ..... | .. | 21.0 | 4½ | | 1,440 |

Hall Electric Light Co.,
404 W. 27th St.
NEW YORK

LIST OF DYNAMOS IN STOCK.

| Designation of machine. | No. lights 2,000 c. p. 10 amp. X | No. lights 1,600 c. p. 8 amp. Y | No. lights 1,200 c. p. 6 amp. Z | No. lights 800 c. p. 4 amp. | Horse-power at pulley of dynamo. | Width of single belt in inches. | Belt speed required. | Weight of dynamo |
|---|---|---|---|---|---|---|---|---|
| G | ..... | 35 | ..... | ..... | 21.0 | 4½ | | 1,440 |
| G | ..... | ..... | 45 | ..... | 21.0 | 4½ | | 1,440 |
| G | ..... | ..... | ..... | 70 | 21.0 | 4½ | | 1,360 |
| H | 40 | ..... | ..... | ..... | 29.7 | 6 | | 1,750 |
| H | ..... | 50 | .. | ..... | 30.0 | 6 | | 1,750 |
| H | ..... | ..... | ..... | ..... | 29.5 | 6 | | 1,750 |
| I | 52 | ..... | ..... | ..... | 38.0 | 8 | | 2,290 |
| I | ..... | 65 | ..... | ..... | 38.6 | 8 | | 2,290 |
| I | ..... | ..... | 83 | ..... | 38.0 | 8 | | 2,290 |
| J | 64 | ..... | ..... | ..... | 46.5 | 10 | | 2,770 |
| J | ..... | 80 | ..... | ..... | 47.1 | 10 | | 2,770 |
| K | 75 | ..... | ..... | ..... | 52.5 | 12 | 5,000 Feet per minute. | 3,200 |

ESTABLISHED 1867.

FRANKLIN S. CARTER,
CHAS. M. WILKINS,
E. WARD WILKINS,
} Trading as

# PARTRICK & CARTER,

MANUFACTURERS OF AND DEALERS IN EVERY DESCRIPTION OF

## Electrical Supplies,

NO. 125 SOUTH SECOND STREET, PHILADELPHIA, PA.

**REMOVAL NOTICE.**—We have removed our offices, storerooms and factory to the large buildings, No. 125 SOUTH SECOND STREET and No. 131 GOTHIC STREET.

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WE MAKE A SPECIALTY OF SUPPLIES FOR HOTEL AND HOUSE WORK.

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Catalogues and Discount Sheets will be sent to those in the trade upon receipt of application and business card.

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MANUFACTURERS OF
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FOR ELECTRICAL PURPOSES
THE S.Y.L. HOMMEDIEU CO
EASTERN AGENTS
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Specialties of all kinds to order
send for
CATALOGUE.

THE B. F. GOODRICH CO.
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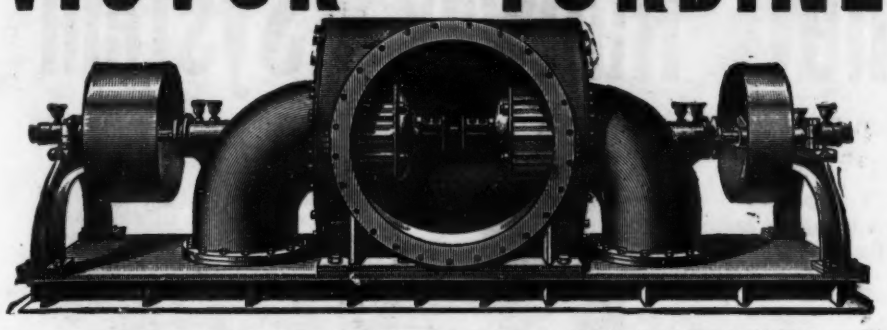
SAMPLES AND PRICES UPON APPLICATION.

# VICTOR TURBINE WATER WHEEL.



The attention of ELECTRIC COMPANIES is called to this **CELEBRATED WATER WHEEL** as particularly adapted to their use, on account of its **remarkably steady motion, high speed and great efficiency** and **large capacity**, for its **diameter**, being **double the power** of most wheels of the same diameter. It is used by a number of the leading electric companies with great satisfaction. In the economical use of water it is without an equal, producing the highest per cent. of useful effect **guaranteed.**

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Our Horizontal "Victor" is highly recommended, as no gears are required, and it can be belted directly to dynamo.

The accompanying engraving represents a pair of 12-inch **VICTOR TURBINES** arranged on a horizontal shaft, with cast-iron Flume, Draft Tubes, End Bearings for Shaft and Driving Pulleys complete, all mounted upon a substantial cast-iron bed plate. The entire arrangement is very complete and strictly first-class in every particular. We are now prepared to furnish Victor Turbines, either single or in pairs, on horizontal shafts, and where the situation admits of their use we recommend them.

**STILWELL & BIERCE MFG. CO. DAYTON, OHIO.**

# Gillinder & Sons,

MANUFACTURERS OF

**Globes and Shades of all Shapes, every description,**

**Opal, Crystal, Obscured and Colored, for ELECTRIC LIGHTING.**

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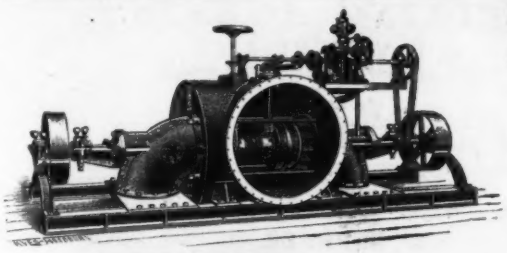
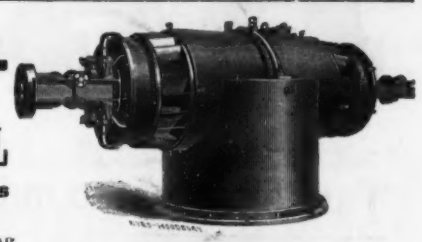


# RODNEY HUNT MACHINE CO.

**Engineers, Machinists, Iron and Brass Founders,**

**TURBINE WATER WHEELS,**
**Iron Flumes and Penstocks,**
**Everything pertaining to**
These wheels are superior for high power and efficiency, excellent workmanship, even speed and great durability. Tight closing gate; easily operated.

**VERTICAL & HORIZONTAL**
**Head Gate Gearing, Regulators**
**Water Wheels and Mill Work**
Used in many of the largest manufacturing establishments in the United States. 6,800 horse power furnished one mill, 7,200 to another, 2,000 in one cotton mill, and one manufacturer 76 wheels. All now running.



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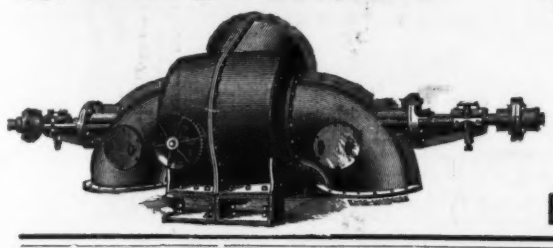
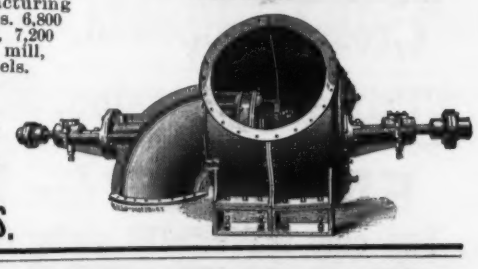
| | |
|---|---|
| 54 in. wheel tested in mill after running two years. ..... .8430 | 30 in. wheel at Holyoke Testing Flume (another wheel)..... .8789 |
| 36 in. wheel at Holyoke Testing Flume.. .8516 | 30 in. (special wheel) at Holyoke Testing |
| 30 in. wheel at Holyoke Testing Flume .. .9050 | Flume..... .8461 |

.7263 at ⅛ gate; proportionately high at intermediate stages.





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# U. S. ELECTRIC RAILWAYS COMPANY,

WOLSTAN R. BROWN, PRESIDENT. LEMUEL WM. SERRELL, M. E., GENERAL MANAGER. WM. L. CLARK, COUNSEL.

## ENGINEERS AND CONTRACTORS

FOR

## ELECTRIC RAILWAYS, STEAM PLANTS, POWER PLANTS.

Attention given to the **REORGANIZATION** of **STREET RAILWAY COMPANIES** desiring to equip with **ELECTRICITY.**

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# STANDARD ELECTRIC SUPPLY COMPANY,

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**AMMETERS.** **VOLTMETERS.**

**SOLAR CARBON BRUSHES.** **SOLAR ARC CARBONS.**

Electric Gas Lighting Supplies. Electric Railway Supplies.

**WIRE**

**TAPE.** **SOLAR CARBON BATTERY PLATES.** **SWITCHES.**

WHEELER'S IMPROVED

# Double Trolley Railway System

(Protected by United States and Foreign Patents.)

The only trolley that cannot become accidentally displaced from double overhead wires, even if one wire breaks
Particularly adapted for difficult situations.

For further illustration and description see THE ELECTRICAL WORLD of July 12, 1890

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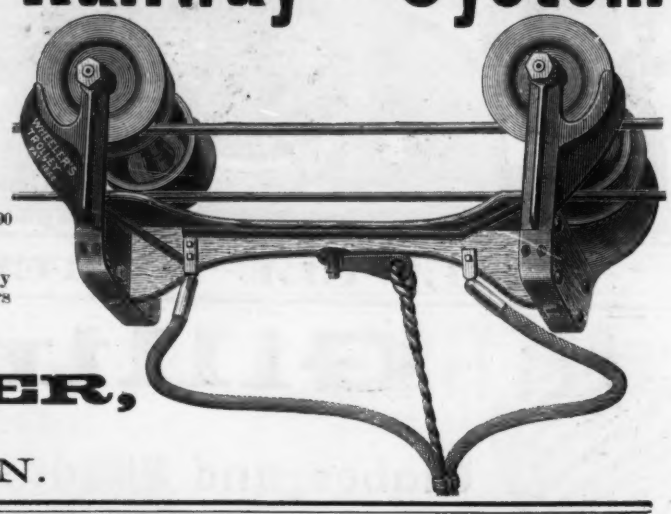
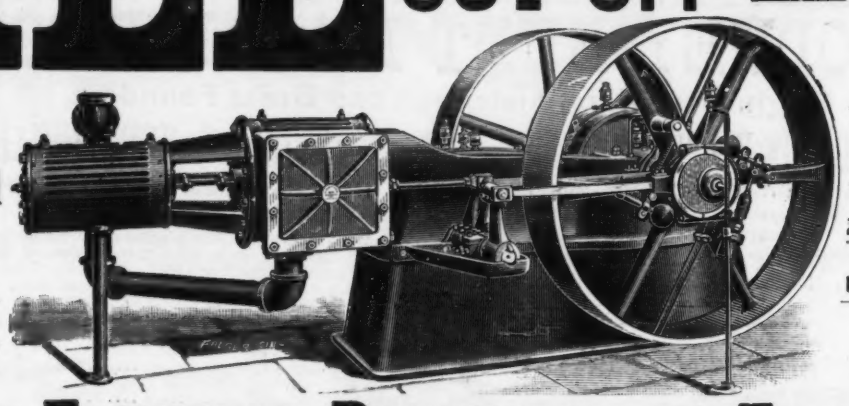


**FRANK WHEELER,**
Manufacturer,
MERIDEN, - - - CONN.

# BALL AUTOMATIC CUT OFF ENGINE

Standard.
Tandem Compound
Cross Compound.
Triple Expansion.



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**ENGINES for ELECTRIC RAILWAYS and ELECTRIC LIGHTING.**
The only GOVERNOR giving ABSOLUTELY the Same Speed under all CHANGES OF LOAD or BOILER PRESSURE.
**BALL ENGINE COMPANY, ERIE, PA.**

GET THE BEST.

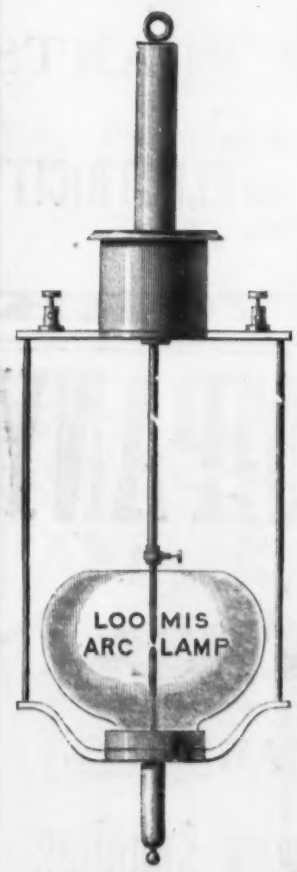
# "LOOMIS SYSTEM"

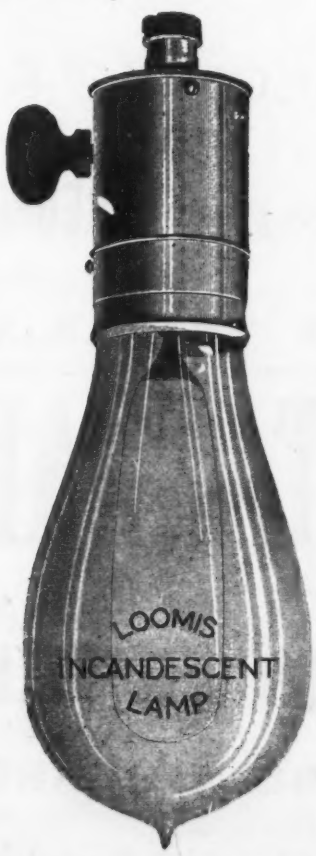
OF

## ARC AND INCANDESCENT LIGHTING.

REQUIRES THE LEAST ATTENTION.

AN IMPROVEMENT ON ALL OTHER SYSTEMS TO DATE.






COSTS THE LEAST TO MAINTAIN.

We are now installing Arc and Incandescent Lights from our **LOW TENSION AUTOMATIC INCANDESCENT DYNAMOS.** Come and see them. They work to Perfection.

Owing to the Automatic Action of our Dynamo, the **ARC LIGHTS** are as uniformly steady and brilliant as the Incandescent, and are free from that flickering and hissing which is so objectionable in the ordinary Arc Light run from a **HIGH TENSION ARC DYNAMO.**

**EUREKA ELECTRIC CO., No. 18 Broadway. N. Y.**

IT PAYS IN THE END.

# K. W. SPECIALTIES

ENDORSED BY ALL USERS:

K. W. Cut-out Rosette, for Cleat Work, Wood or Porcelain.
" " " " Moulding " " "
" " " " Concealed " " "
" No. 2 1-30 ampere Main Cut-out, Porcelain.
" No. 16 1-50 " " "
" No. 15 1-10 " Branch " "
" No. 7 1-30 " " "
" Bracket Cut-out. Wood.

## PETTINGELL ANDREWS COMPANY., Sole Manufacturers,

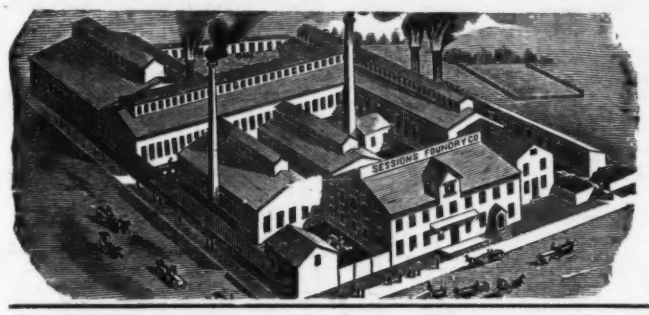
192-202 Summer Street, Boston.

**THESE GOODS KEPT IN STOCK BY DEALERS EVERYWHERE.**

# LAMINAR FIBRE.

**A perfect substitute for hard rubber for insulating and mechanical purposes. Thoroughly homogeneous and practically indestructible. Furnished in sheets or tubes of various lengths and thicknesses; can be cut, turned or drilled into any desired shape. Will take a very high degree of polish; is also a perfect bearing for light running machinery.**

**LAMINAR FIBRE GOODS CO., 180 Summer Street, Boston, Mass.**




## IRON CASTINGS FOR ELECTRICAL PURPOSES.

**We cast Dynamo Magnets of a special mixture of iron that gives much better electrical results than ordinary castings. Also small castings for Electrical Work, and castings, large and small, for all purposes, of finest quality. OUR PRICES ARE LOW. We run four large cupolas constantly, melting about 35 tons daily. Correspondence Solicited.**

**SESSIONS FOUNDRY CO., Bristol, Conn.**

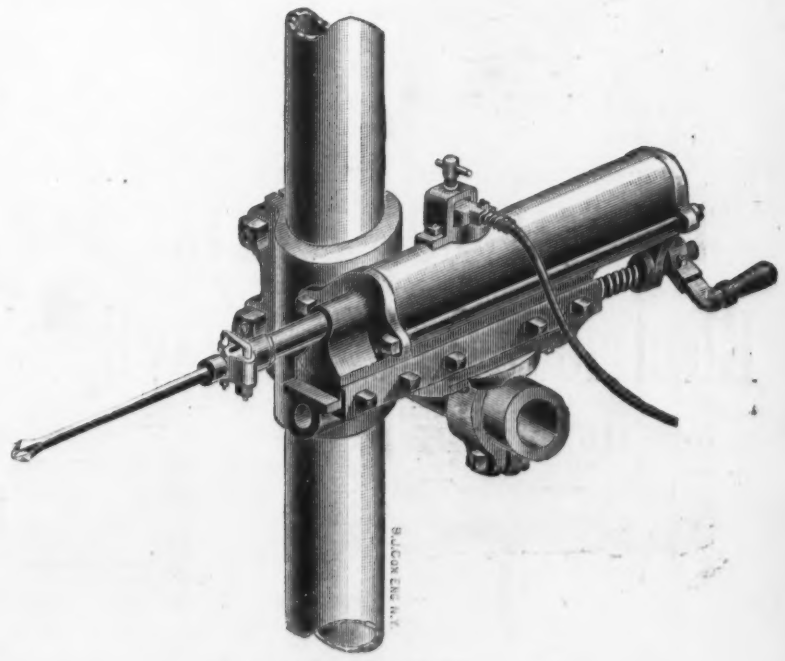
# Edison General Electric Company,

EDISON BUILDING, BROAD STREET, NEW YORK.

# ELECTRIC PERCUSSION DRILLS

## (THE MARVIN SYSTEM OF PERCUSSION TOOLS).

This Drill contains neither Commutator, nor Moving Contacts.
All Circuits are protected in closed Metallic Cases.
More Economical, Simpler and More Easily Handled than Steam or Air Drills.
Safe and Reliable; Not Affected by Moisture, Dampness and Dripping Water.
Can be Operated by ordinary Miners or Quarry Men.
Weight of Drill with Tripod, about 400 pounds.
Speed of Drilling in Hard Granite, 2-inch hole, 2 inches deep per minute.



**Please address all communications for Circulars and Prices to nearest District Office as indicated below.**

MAIN DISTRICT OFFICES:

**Canadian District, Bank of Commerce Building, Toronto, Can.**
**Central District, Rialto Building, Chicago, Ill.**
**Eastern Building, Edison Building, Broad Street, New York.**
**New England District, 38 Pearl Street, Boston, Mass.**
**Pacific Coast District, Edison Building, 112 Bush St., San Francisco, Cal**
**Pacific Northwest District, Fleischner Building, Portland, Ore.**
**Rocky Mountain District, Masonic Building, Denver, Col.**
**Southern District, Cotton Exchange Building, New Orleans, La.**

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# HILL

## Clutch Works

CLEVELAND, O.

EASTERN OFFICE:
18 Cortlandt Street, NEW YORK
CHICAGO OFFICE, 347 The Rookery.
KANSAS CITY: 1,221 and 1,223 Union Av.

ELECTRIC LIGHT PLANTS

Designed, Erected & Furnished.
Clutches made with 2, 4 and 6 Arms.

*Send for new Catalogue, Power Transmission Machinery.*

WALTER C. WRIGHT, C. E. E. EUGENE STARR.

# WRIGHT & STARR,

CONTRACTING AND CONSULTING ELECTRICAL ENGINEERS,

**Electrical Testing, Calibration of Instruments, Etc.**

Office, 37 S. Third St. Laboratory, 4015 Baring St.
PHILADELPHIA, PA.
Telephone, 114. Telephone 134, West Philadelphia.

## A PERFECT ELECTRIC LIGHT GLOBE.

# UNION GLASS CO.

BOSTON, MASS.
FACTORY AND POST OFFICE ADDRESS:
SOMERVILLE, MASS.

MANUFACTURERS OF EVERY DESCRIPTION OF
ELECTRIC LIGHT GLOBES
AND
INCANDESCENT SHADES and BULBS.

# BROADWAY ELECTRIC CO.,

703 BROADWAY, NEW YORK.

## THE ELECTRICAL EXCHANGE.

ELECTRICAL
Moving Figures
For Window Attractions & Advertising Novelties
TO SUIT EVERY TRADE
MADE TO ORDER.

WE WILL BUY, SELL, EXCHANGE OR LET OUT ANY THING ELECTRICAL NEW OR USED FROM AN ELECTRIC LIGHT STATION TO A HORSE SHOE MAGNET.

J. W. EMERSON, Pres. C. R. MESTON, Secy. A. W. MESTON, Manager.

# THE EMERSON ELECTRIC MFG. CO.,

MANUFACTURERS OF

## Electric Light & Railway Specialties.

THIS WEEK'S SPECIALTY:

**Our "Midget" Hard Rubber Fixture Cut-Out.**

CUT FULL SIZE.

Dimensions { Length of Cut out (over all), 1 9/16 inches. " " Cover " " 1 1/16 " External diameter of Cover, 1/2 " Internal " " " 13/16 "

As will be seen by the cut and dimensions,
This is the smallest and neatest fixture cut-out made.
It will go into any canopy, however small.
The length of fuse and space inside of cover is ample.
It conforms to the Underwriters' requirements.

WRITE FOR PRICES.

Office and Factory: 513 Elm Street, St. Louis, Mo.

TELEGRAPH, TELEPHONE AND ELECTRIC LIGHT **CEDAR POLES**

H. C. RIPLEY
EAST SAGINAW, MICH.

All Lengths. Orders Promptly Filled.

Cleverly 1018 CHESTNUT ST. PHILA.

# Electric Specialties.

WE MAKE
ELECTRIC SUPPLIES UNDER CONTRACT.

# J. H. WILLIAMS & CO.,

9-15 Richards St. (near Hamilton Ferry), Brooklyn, N. Y.,
MANUFACTURERS OF

## DROP-FORGED SPECIALTIES

IN IRON, STEEL, COPPER AND BRONZE.

*ENGINEERS' WRENCHES, LATHE DOGS, THUMB-NUTS, THUMB-SCREWS, SHAFTING COLLARS, KEYS.*

BROCK'S PATENT CHAIN PIPE WRENCH.
Makers of Electrical Drop Forgings of every description.

# STANDARD THERMOMETER CO.,

ELECTRICAL

INDICATING AND RECORDING INSTRUMENTS,

For Electric Light and Power Stations, Steam Plants, Water-works, Kilns, Ovens, and Kettles, Cold Storage Warehouses, etc.

Continuously indicating and recording at one or more distant points changes of Temperature, Steam, Water or Gas Pressure, Height of Water. Dial Thermometers for all purposes. Catalogues on application.

PEABODY, MASS.
New York Office: Room 413, Telephone Building, 18 Cortlandt Street.

# EIMER & AMEND,

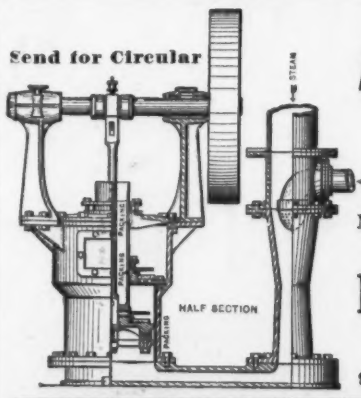
205, 207, 209 & 211 THIRD AVENUE,
NEW YORK,

## IMPORTERS.

CHEMICALLY PURE

# SAL-AMMONIAC,

ESPECIALLY FOR USE IN BATTERIES.




IMPROVED BELT POWER

## AIR PUMP and CONDENSER

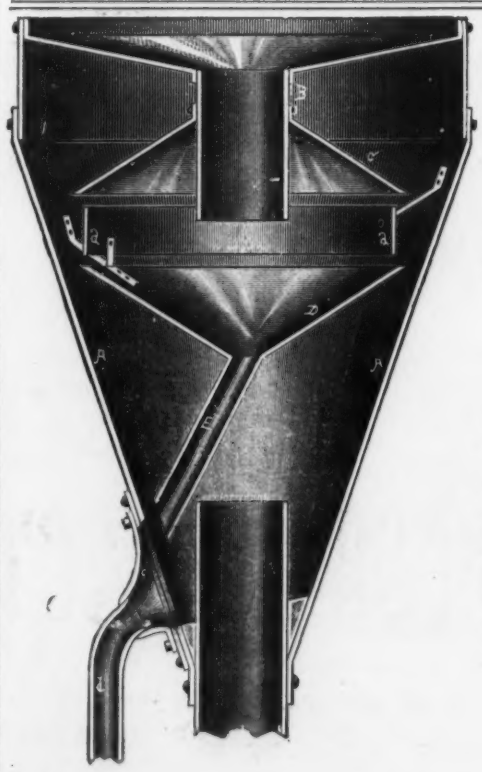
Specially adapted to High Speed Compound Engines. Also to existing engines where a saving of fuel or a corresponding increase of power can be effected.

NO AIR LOCKS. HIGHEST EFFICIENCY.

*Specially suited to the requirements of*

ELECTRIC LIGHT and POWER PLANTS.

CONOVER & CO.,
Consulting and Mechanical Engineers,
95 and 97 Liberty Street, - NEW YORK



ESPECIALLY ADAPTED FOR

## HIGH SPEED ENGINES.

LYMAN & WARREN'S
IMPROVED STEAM

# EXHAUST PIPE HEAD,

For the Protection of Roofs and Walls of Buildings from the Exhaust Steam in Steam Engines, etc.

The Exhaust Steam Condensation from Exhaust Pipes of Steam Engines when discharged above roofs and alongside of walls will, in a short time, destroy the roofs and wash away the mortar in brick walls, as this condensation is always hot, is, therefore, very destructive. This Condensing Head will entirely avoid any such difficulty and thoroughly protect the roofs of buildings and sides of walls. The condensation can also be utilized again, which will reduce the water rent. There is no back pressure on the Exhaust, and the escape is noiseless.

SEND FOR PRICE LIST.

## F. B. ASPINWALL.

121 LIBERTY ST., N. Y.

## WANTED.

ELECTRICAL SALESMAN WANTED.—A MAN who understands construction, to sell electrical apparatus in Western New York. Liberal commission. Address ACCUMULATOR, Care THE ELECTRICAL WORLD, New York.

MANAGER WANTED—A MANAGER TO ORganize a company and take charge of introducing important electrical inventions. Must be a practical business man of ability and be able to secure capital. Address E. F. A.,
Care THE ELECTRICAL WORLD, New York.

SITUATION WANTED—BY A MECHANICAL engineer and draughtsman. Three years' experience on designing and operating electric machinery. First-class references. Address G. R.,
Care THE ELECTRICAL WORLD, Chicago.

SITUATION WANTED BY AN ELECTRICIAN (28), sound theoretical knowledge, and eight years' practical experience in telephony and electric lighting. Speaks French and Spanish, and will take hold anywhere. Salary, $1,200. Address A. B. C.,
Care THE ELECTRICAL WORLD, New York.

SITUATION WANTED JAN. 1, 1891.—A FIRST-class business man, aged 40, at present representing a prominent electrical concern, and possessing a large and influential business acquaintance, is open to engagement; salary moderate; references unquestionable. SYDNEY, Post Office Box 3348, New York City.

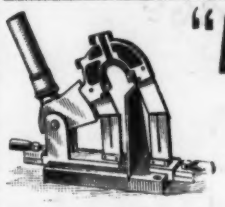
SITUATION WANTED BY A PRACTICAL MAN as inspector or superintendent of construction, now holding similar position. Extensive experience in central station and isolated work. Served as machinist. Familiar with steam and electrical repairs. Competent to estimate or canvass. Best references. Prefer this vicinity. Address PRACTICAL,
Care THE ELECTRICAL WORLD, New York.

SITUATION WANTED.—THE ADVERTISER will be open to accept a position as manager of electric light or power station after Jan. 1, 1891. Is a thorough business man, a practical engineer and electrician, and a worker. Has had seven years' experience in the management, construction and re-construction of both arc and incandescent stations. Best of references from past and present employers. Address MANAGER,
Care THE ELECTRICAL WORLD, New York.

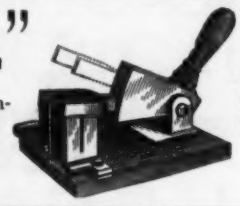
SITUATION WANTED.—AN ELECTRICAL ENgineer of ten years' experience desires a position, where ability will be recognized, as foreman of car sheds, or superintendent of electric railway company or electric light station. Is up to the times in construction work, and has been handling men for years. Salary moderate. Can begin at once. Address FOREMAN,
Care THE ELECTRICAL WORLD, Boston, Mass.


**PLATINUM** JAS. SCHAWEL & CO., 29 John St., New York.
Importers and Melters, Wholesale and Retail. Scrap Purchased.

**NASSAU**
CAPSULE BATTERY, 3 Inches by 5-8Inches.
PORTABLE BELL OUTFIT.
ELECTRIC ALARM THERMOMETER.
NASSAU ELECTRICAL COMPANY, 19 Park Place, New York.



"AJAX SWITCHES."
Made in all Sizes for any Potential
With Single, Double and Triple-Pole Connections. Simple. Cheap. Indestructible. Correspondence Solicited.
MANUFACTURED BY
C. S. VAN NUIS,
74 Cortlandt St., New York.



Station Dynam Switch.

VALVE OIL FOR INTERNAL
ENGINE OIL FOR EXTERNAL
LUBRICATION OF STEAM ENGINES.
ELECTRIC DYNAMO OIL
ADAPTED TO ALL STYLES OF DYAMOS.
Send for Trial Packages.
A. W. HARRIS OIL CO., Providence, R. I.
THE E. P. ALLIS CO., MILWAUKEE, WIS., NORTHW'SN AGTS.

ELECTRIX
Switches, Sockets, Rosettes.
SIMPLEX WIRES.
W. H. GORDON & CO.,
115 BROADWAY, NEW YORK,
SELLING AGENTS.


## WANTED.

TO DIRECTORS OF ELECTRIC COMPANIES.

SITUATION WANTED BY A MANAGER AT present in charge of a large electric light station, who wishes to change for satisfactory reasons. Can demonstrate by results his ability as an electrical and mechanical engineer and as business manager. Prospects of future growth of company will be considered with salary, but only those whose business will warrant the payment of at least $3,000 salary to the right man need answer. Address J.,
Care THE ELECTRICAL WORLD, New York

WANTED Advertisements continued on page XXII.


ALUMINUM, $2 PER POUND.

The Pittsburgh Reduction Company, 95 Fifth avenue, Pittsburgh, Pa., U. S. A., offer commercially pure aluminum at the following rates at Pittsburgh, Pa.:

Lots of 1,000 lbs. and over....$2.00 ₱ lb.
Lots of 500 lbs. and over.....2.25 ₱ lb.
Lots of 100 lbs. and over.....2.50 ₱ lb.

Metal guaranteed to be equal in quality to the best metal manufactured by any other process.
Prices on sheets, wire, tubes or castings given upon application.

Do you use
THE LAW BATTERY?
If not, why not?

The Cheapest Battery and the Best.
LAW TELEPHONE CO.,
85 John St., New York.

CLARK
ARC SYSTEM
SEND FOR CATALOGUE B.
Is the Cheapest and Most Economical in the United States.
Manufactured by The CLARK ELECTRIC CO., 192 Broadway, New York.

THE COLUMBIA INCANDESCENT LAMP
Recognizes no Superior. Long Life. Full Candle Power, High Efficiency. Orders filled with promptness. Special Lamps for Electric Railways.
SEND FOR NEW CATALOGUE AND PRICE LIST.
COLUMBIA INCANDESCENT LAMP COMPANY,
1912 and 1914 Olive Street, St. Louis, Mo.

Huntington Search Lamps.
FOCUSING LAMPS FOR PHOTO-ENGRAVING.
ELECTRO CALCIUM LAMPS FOR THEATRES.
ARC LAMPS FOR INCANDESCENT CIRCUITS.
SEND FOR CIRCULARS. MANUFACTURED BY SEND FOR ESTIMATES.
THE SCOTT ELECTRICAL MFG. CO., 26 Liberty St., New York.

THE "CLARK" WIRE.
Insulation Guaranteed wherever Used, Aerial, Underground or Submarine.

In a letter from the INSPECTOR of the **Boston Fire Underwriters' Union**, under date of March 29, 1886, he says: "**A Thoroughly Reliable and Desirable Wire in every respect.**"
The rubber used in insulating our wires and cables is especially chemically prepared, and *is guaranteed to be waterproof*, and *will not deteriorate, oxidize* or *crack*, and will remain flexible in extreme cold weather, and is not affected by heat. The insulation is protected from mechanical injury by one or more braids, and the whole slicked with Clark's Patent Compound, which is water, oil, acid, and to a very great extent fireproof. *Our insulation will prove durable when all others fail.* We are prepared to furnish Single Wires of all gauges and diameter of insulation for Telegraph and Electric Lights from stock. Cables made to order.
We are now prepared to furnish our Clark Wire with a *White Outside Finish* for ceiling cleat work as well as our standard color.
**CLARK JOINT GUM** should be used for making water-proof joints. This is put up in half-pound boxes, in strips about one foot long and five-eighths inch wide, and when wrapped about a joint and pressed firmly it makes a solid mass.
**FOR RAILWAY AND MOTOR** use, we make all sizes of stranded and flexible cables with Clark insulation. Wire Tables and price list will be furnished on application to

EASTERN ELECTRIC CABLE COMPANY,
61 to 65 Hampshire Street, Boston, Mass.
HENRY A. CLARK, General Manager. HERBERT H. EUSTIS Electrician.

Electric Light Specialties.
"CANVAS JACKET" Moistureproof Wire.
"BISHOP" White Core Wires.
"ELECTRIX" Single Pole Switches.
"ELECTRIX" Lamp Sockets. Porcelain Cut-out Rosettes, etc.
POLES.
ILLINOIS ELECTRIC MATERIAL COMPANY,
339-341 ROOKERY BUILDING, CHICAGO, ILL.

STANDARD
ELECTRICAL TEST INSTRUMENTS.
AMPERE METERS. VOLTMETERS.
ALL THE LEADING TYPES.
Queen's Portable Testing Sets.
Reflecting Galvanometers. Resistance Coils.
Wheatstone Bridges. Testing Batteries.
Portable Photometers. Laboratory Photometers.
Speed Counters. Tachometers.
SEND FOR CATALOGUE 1-66 OF ELECTRICAL TEST INSTRUMENTS.
QUEEN & CO., Philadelphia.

## WANTED.

*Continued from page XXI.*

ARC DYNAMOS WANTED.—SECOND-HAND Brush arc dynamos, with and without lamps, in good condition, for cash. State use and number of lights capacity. No brokers. Address P. O. Box 813, Birmingham, Ala.

REPAIRER WANTED AT ONCE FOR A CANADIAN city. A man who thoroughly understands repairing Thomson-Houston arc lamps and dynamos, also Westinghouse dynamos and apparatus. None but a good hand need apply. State wages expected and send photo to CANADA,
Care THE ELECTRICAL WORLD, New York.

## FOR SALE.

ENGINES.—ONE 70 H. P. ARMINGTON & Sims' engine; one 40 h. p. Buckeye engine; one 10 h. p. Westinghouse engine. All in good condition. MATHER ELECTRIC CO., Manchester, Conn.

ELECTRIC LIGHT PLANT, CAPACITY 1,350 incandescent lamps, Westinghouse system; two Westinghouse automatic engines; two dynamos; in county seat town of 2,500 inhabitants. Plant in first-class running order, and paying dividend. Price $12,000, part cash, balance on time. Satisfactory reasons for selling. Address SEWARD ELECTRIC LIGHT AND POWER CO., Seward, Neb.

ELECTRIC LIGHT PLANT AND GAS WORKS.—The owners of the Red Bluff Electric Light and Gas Company have decided to offer the entire stock for sale. The plant, both the gas and electric light works, is in first-class condition and earning a fair profit on the investment. The gas works are located in the town. The electric light works are run on Antelope Creek by water power.

The stock offers a first-class investment for permanent and increasing income.
RED BLUFF ELECTRIC LIGHT AND GAS COMPANY, RED BLUFF, Cal.

**SYRACUSE ROLLING MILL MACHINERY**

One 500 H. P. Vertical Buckeye Engine, 34 × 30 in. cylinder. One 300 H. P. Vertical Corliss Engine, 24 × 36 in. cylinder. One Muck Bar Train, 19 in. rolls, 3 high. Four Merchant Trains, 16, 14, 9 and 8 in., 3 high, including over 200 new spare turned Rolls, also Housings and Bed-Plates complete, all of modern construction. One Squeezer, large size; also Floor Plates, Water Boxes, Shears, Ore Crusher, Scales, Shafting, Pulleys, etc. One No. 11 Sturtevant Blower, and others smaller. One Cameron Steam Pump, 12 × 7 × 12 in.; also three No. 7 Blake, Dean and Knowles. Five Steam Drills. Four Horizontal Tubular Boilers, 5 × 18 ft., 80 H. P. each, double riveted, flush front and full fixtures. One new Flue Boiler, 50 H. P., and others in good order. One Porter Horizontal Engine, 80 H. P., 15 × 24 in. cylinders. One Vertical Engine, 60 H. P., 14 × 15 in. cylinder. Complete Machine Shop Tools, Lathes, Planers, Drill, etc. One Ingersoll Compressor, 24 × 30 in., in first-class condition. One 90 H. P. Horizontal Tubular Boiler, insured at 80 lbs. One Sullivan & Ehler High-Speed Engine, 8× 10 in. Address
GEO. M. CLAPP, Agt., 74 Cortlandt St., New York.

**ARC APPARATUS.**

One 30-light Fort Wayne Jenney dynamo, with 23 single lamps (low tension).
One 45-light Western Electric dynamo, with 40 single lamps (low tension).
One 10-light Sperry dynamo, with 8 single lamps, low tension.
Twenty-four single Indianapolis Jenney lamps (low tension).

**INCANDESCENT APPARATUS.**

One 500-light Edison dynamo, 110 volts.

**ENGINES.**

Two 7 h. p. vertical Straight Line engines, (new). One 5 h. p. Westinghouse engine. One 40 h. p. Westinghouse.
One 25 h. p. N. Y. Safety (automatic).
One 40 h. p. Rice (automatic).

FRANK A. WUNDER,
456 THE ROOKERY, CHICAGO.

# Sperry Dynamos.

**TEN 20-LIGHTERS with LAMPS.**
We will sell these **Cheap.** Make an offer.
**ROSE ELECTRIC LIGHT SUPPLY CO.,**
1106 PINE STREET, ST. LOUIS, MO.

**ARC DYNAMO AND LAMPS.**
2, 5, 6, 7, 10, 20, 25, 50-50 light.
**INCANDESCENT DYNAMOS.**
25, 50, 60, 75, 150, 300, 500 lights.
Also, Arc and Incandescent Motors. Dynamos Wanted.
Large stock of Telegraph Instruments, Testing Sets, Resistance Coils, Batteries, etc., cheap. Write for particulars.
**W. S. CHESLEY, 171 Broadway, N. Y.**

# WILL BE SOLD CHEAP.

**W. E. Co. "Gilliland" Magneto Call Bells, $4.50 each.**

**W. E. Co. Standard Switch-boards, new, 25 and 50 drops.**

**"Williams" Switch-boards, 50 drops, complete, $100.**

The goods were made under U. S. Patents, and bought of the Western Electric Company, and their use is licensed in the U. S.

APPLY TO

**The Tropical American Telephone Co.**
18 Cortlandt Street, New York.

THE ELECTRICAL SUPPLY CO.
171 RANDOLPH ST.
CHICAGO

# IN PRINT.

# "D-I-V-I-D-E-N-D-S"

AND

# "HOW TO GET 'EM,"

**A Tale of "Shield Brand" and other good things.**

## CHAP. I.

Poor insulation. Jim's death. An investigation. Great loss of current discovered. Moisture proof insulation recommended. Shield Brand adopted. Great saving in fuel. More satisfactory service. Increased patronage. Alderman O'Tomfool's "underground" motion defeated.

## PRESS COMMENTS.

"An interesting tale well told. . . . The author is bound to die a millionaire. All electric lighting companies should remember that the adoption of Shield Brand for overhead insulation will lead to improved service, increased patronage, and decreased expenses."—*New York Dem. Rep.*

"We think the first question St. Peter will ask former managers of electric light plants, when they have ceased to be '*grounded*,' and apply for admission, will be 'Did you use 'Shield Brand' insulation when running your plant, or, are you one of those persons who continually annoyed our lighting system by running half the electricity you generated into the earth, by using inferior 'weatherproof' insulations?"—*Chicago Enterprise.*

The subject is endless—but our space is not.—Adieu.

## FOR SALE.

DYNAMOS, LAMPS, ETC., AT LOW PRICES.—One 1-light 6,000 c. p. American new dynamo, quadrant regulator; one 3-light 2,500 c. p. American new dynamo, quadrant regulator; one 6-light 2,000 c. p. "Fuller" second-hand dynamo, hand regulator; one 25-light 2,000 c. p. American, new dynamo, hand regulator; two 35-light 2,000 c. p. American new dynamos, hand regulator; one 35-light 2,000 c. p. American second-hand dynamo, hand regulator; one 50-light 2,000 c. p. American new dynamo, hand regulator; 35 single and 8 Duplex Lamps (American switchboard). Switches and Cut-outs, Ammeter, Belting and also a lot of Incandescent Lamps and Holders (Key and Keyless), Bernstein Lamps and fixtures, and a 60 h. p. "Ball" engine in good order. ELECTRIC,
Care THE ELECTRICAL WORLD, New York.

## ON HAND.

One 8-light Van Depoele Dynamo, with six 2,000 c. p. lamps; one 10-light U. S. Dynamo, with ten 2,000 c. p. lamps; one 10-light Excelsior Dynamo, with ten 1,600 c. p. lamps; eight 16-light Fort Wayne Jenney Dynamos, with 2,000 c. p. lamps; ten 35-light Fort Wayne Jenney Dynamos, with 2,000 c. p. lamps; one 20-light American-Wood Dynamo, with twenty 1,600 c. p. lamps; two 35-light American-Wood Dynamos, with thirty-five 1,600 c. p. lamps; ten 20-light Sperry Dynamos, with two hundred 2,000 c. p. lamps; two 20-light U. S. Dynamos, with twenty 2,000 c. p. lamps; three 25-light Western Electric Dynamos, with seventy-five 2,000 c. p. lamps; two 45-light Western Electric Dynamos, with ninety 2,000 c. p. lamps.

## WILL HAVE IN 30 DAYS.

Three 35-light Waterhouse Dynamos, with ninety-five 2,000 c. p. lamps: one 40-light Westinghouse Alternator, with thirty-six 2,000 c. p. lamps; one 30-light Excelsior Dynamo, with eighteen 2,000 c. p. lamps.

## ON HAND.

One No. 2 90-light Edison Shunt Wound Dynamo, 110 volts; one No. 4, 180-light Edison Shunt Wound Dynamo, 110 volts; one No. 20 800-light Edison Shunt Wound Dynamo, 110 volts; one 150-light U. S. Shunt Wound Dynamo, 70 volts; one 150-light U. S. Shunt Wound Dynamo, 300 volts; two 250-light U. S. Shunt Wound Dynamos, 600 volts; two 300-light U. S. Shunt Wound Dynamos, 110 volts; two 300-light Fort Wayne Shunt Wound Dynamos, 110 volts.

## ROSE ELECTRIC LIGHT SUPPLY CO.,

1106 PINE STREET, ST. LOUIS, MO.

## PROPOSALS.

MUNICIPALITY OF BOMBAY.
ELECTRIC LIGHTING.—NOTICE.

Sealed Tenders will be received by the Municipal Commissioner for the City of Bombay up to 1 P. M., on Monday, Feb. 16, 1891, for experimental lighting by electricity of certain streets of the City of Bombay for a period of two years.

2. Forms of tender and schedule of conditions and a sketch of the portion of the city, shewing the streets to be lighted may, on payment of $5, be obtained from Charles Hallett Clark, Washington Buildings, No. 1 Broadway, Rooms 209 and 210, New York, who will on application give any further information that may be required.

3. Tenders must be accompanied by a deposit of rupees one thousand in cash (not to bear interest) or in public securities for that amount to be paid to the Chief Accountant of the Municipality of Bombay, which will be forfeited to the Corporation in case of refusal to sign the contract embodying the conditions mentioned in the schedule above referred to.

4. A further payment to make the total deposit equivalent to 5 per cent. on the contract amount will have to be made by the tenderer whose tender may be accepted before signing the contract.

5. The Municipal Commissioner does not bind himself to accept the lowest or any tender.

By order of the Municipal Commissioner,
RIENZI WALTON,
Executive Engineer, Municipality.
EXECUTIVE ENGINEER'S OFFICE,
BOMBAY MUNICIPALITY,
BOMBAY, Oct. 13, 1890.

## MACHINERY IN STOCK.

Engine Lathes.—42 in. x 12 ft.; 32 in. x 12 ft.; 29 in. x 15 ft.; 24 in. x 28 in. x 20 ft.; 1 each 24 x 10 ft., 12 ft. and 16 ft.; 1 each 17 in. x 6 and 8 ft.; 1 each 16 in. x 6, 8 and 10 ft.; 1 each 14 in. x 6 and 8 ft.; 6 12 in. x 5 ft.; 2 each 11 in. x 4 and 5 ft.; 2 each 10 in. x 4 ft., power or foot power; 1 16 in. x 6 ft., 15 in. x 6 ft., 14 in. x 5 ft. Fox Monitor Lathes; 1 15 in. x 6 ft. Square Arbor Fox Lathe; 1 each 15 in. x 6 ft. and 14 in. x 5 ft. Turret Lathe; 1 Engine Lathe, 14 in. x 6 ft. Toper.
1 Iron Planer, 16 in. x 16 in. x 3 ft.
1 Planer, 20 in. x 20 in. x 4 ft. and 22 in. x 22 in. x 5 ft.
1 " 24 in. x 24 in. x 5½ and 6 ft.
1 " 30 in. x 30 in. x 6 ft. 30 in. x 30 in. x 9 ft.
1 " 32 in. x 32 in. x 10 ft. 42 in. x 36 in. x 12 ft.
1 " 36 in. x 28 in. x 10 ft.
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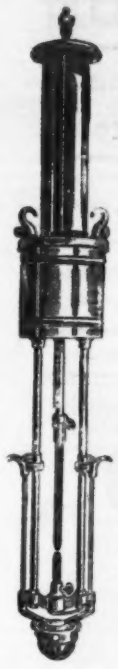

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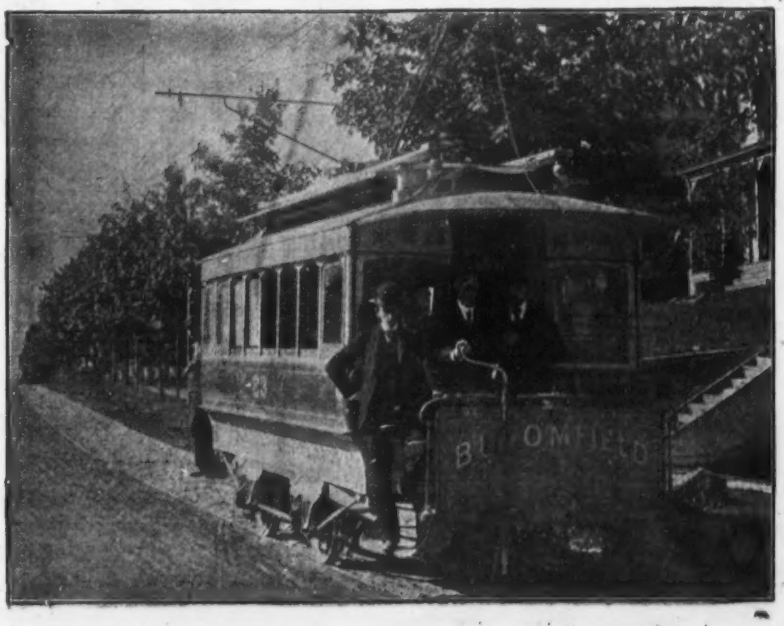

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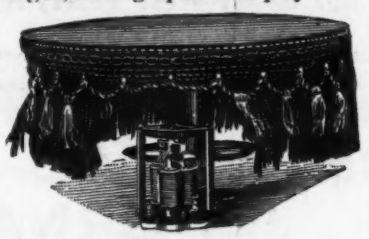

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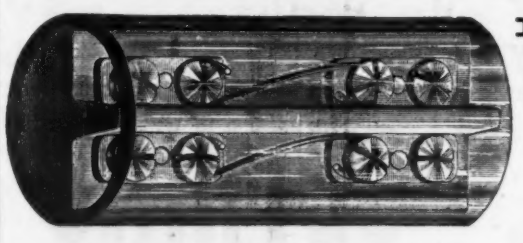

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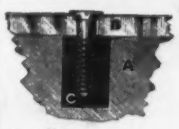

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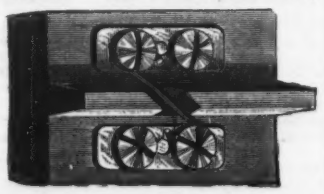

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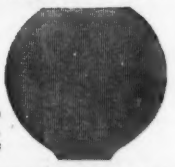

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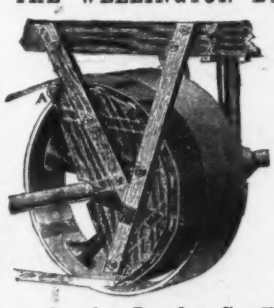

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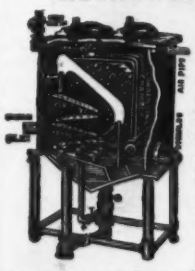

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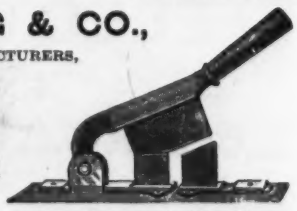

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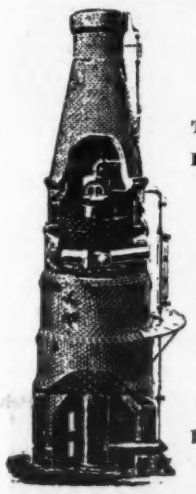

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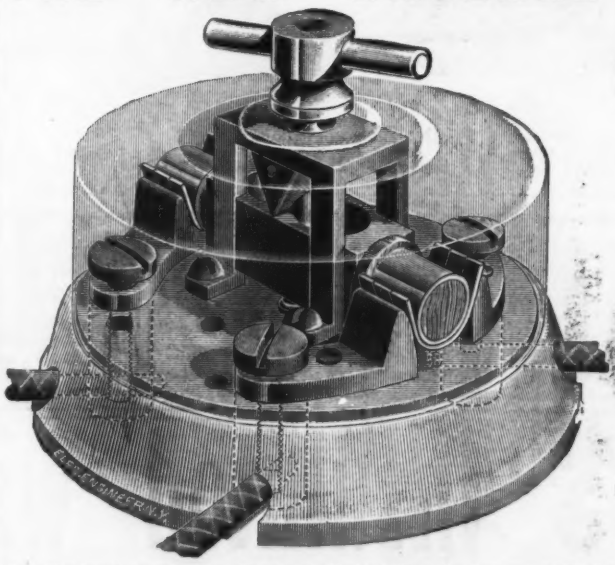

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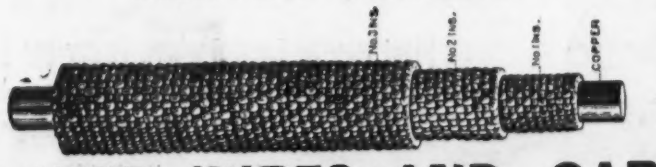


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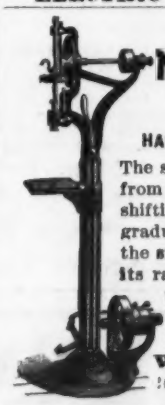

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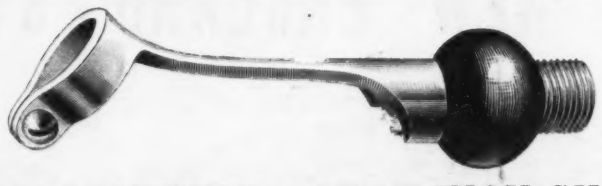

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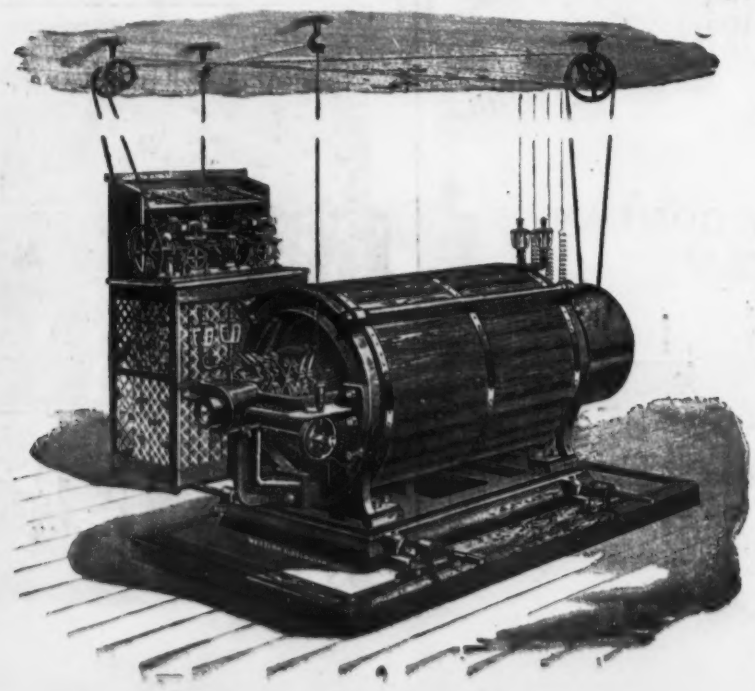

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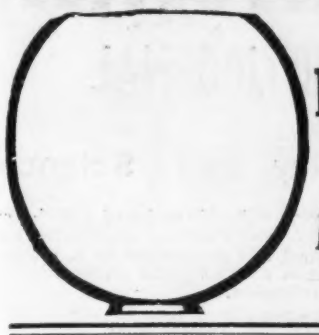

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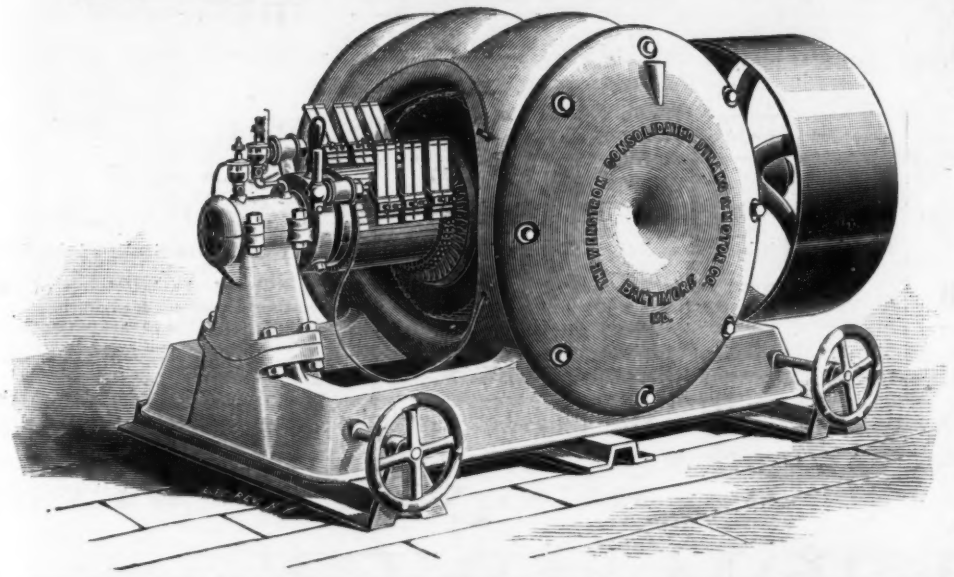

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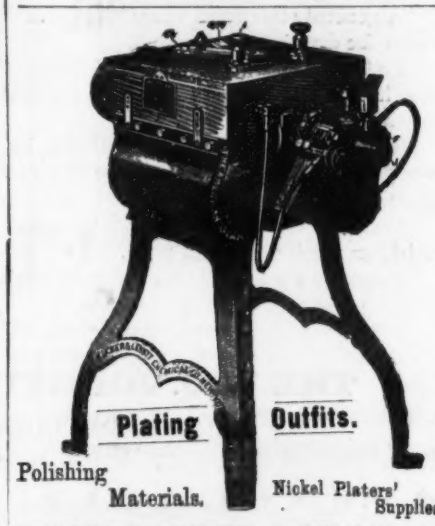


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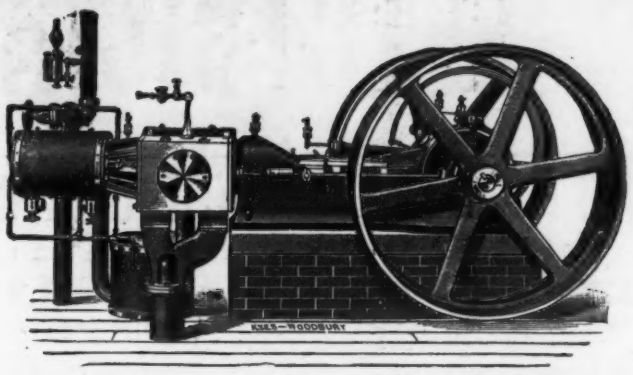

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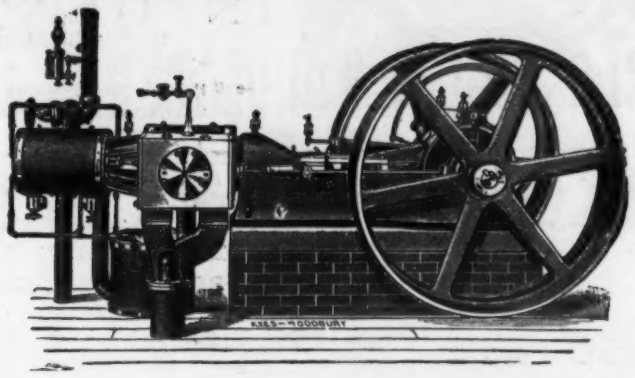

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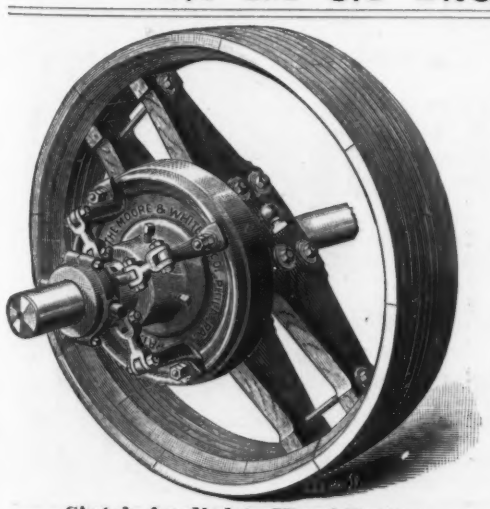

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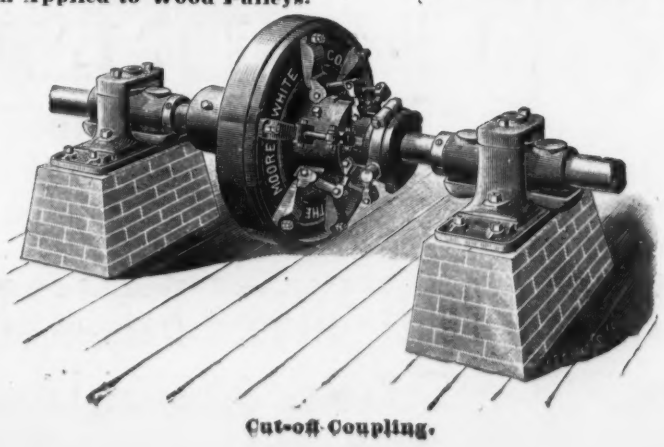

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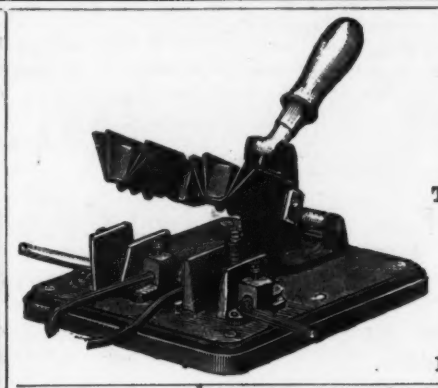

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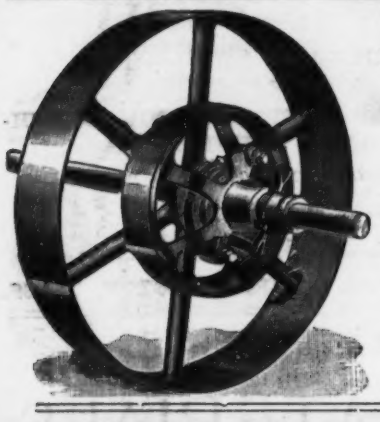

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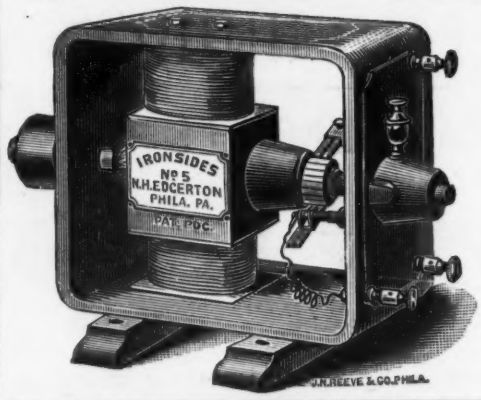


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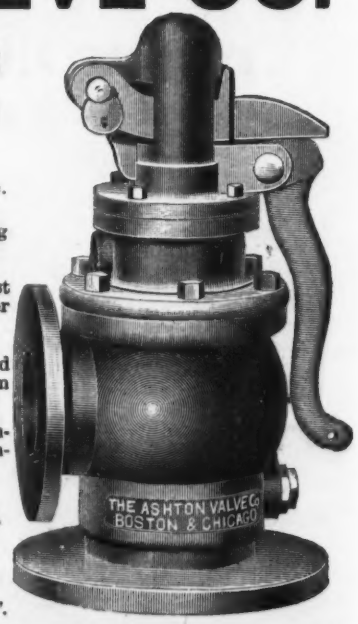


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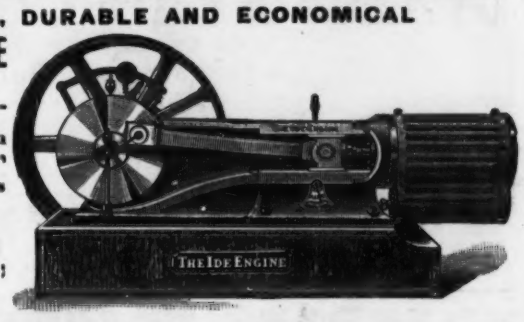


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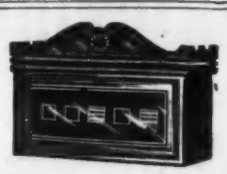

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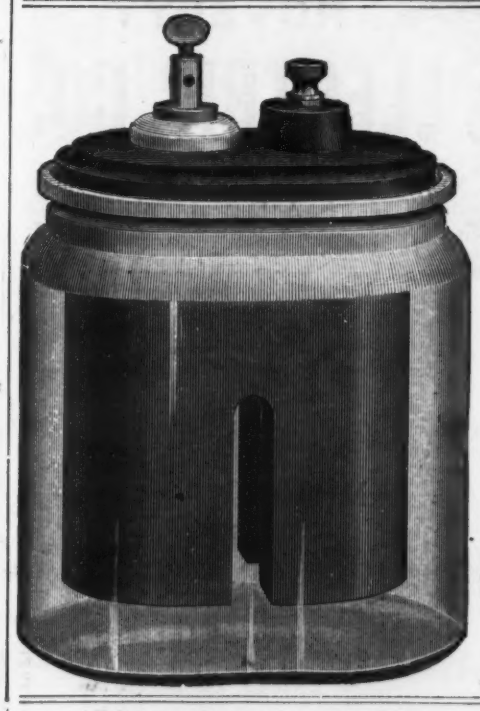

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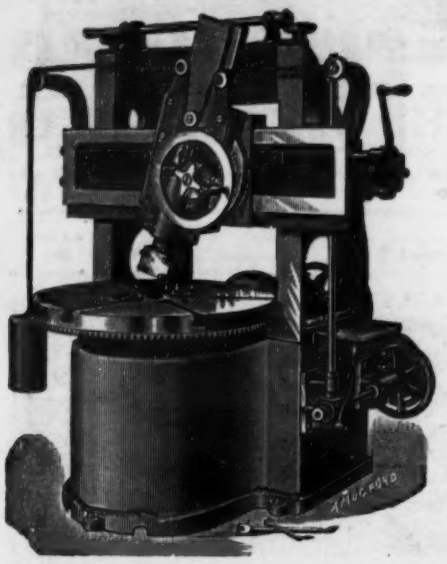

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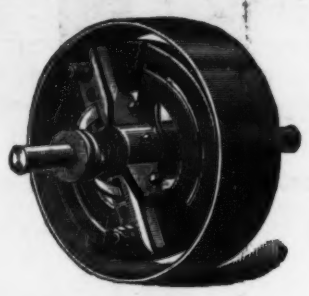

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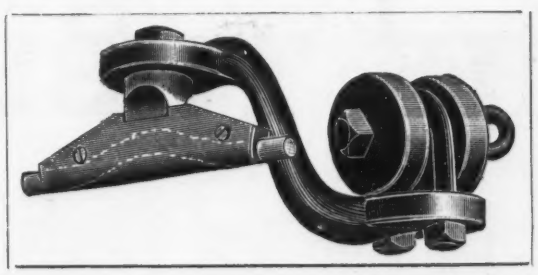

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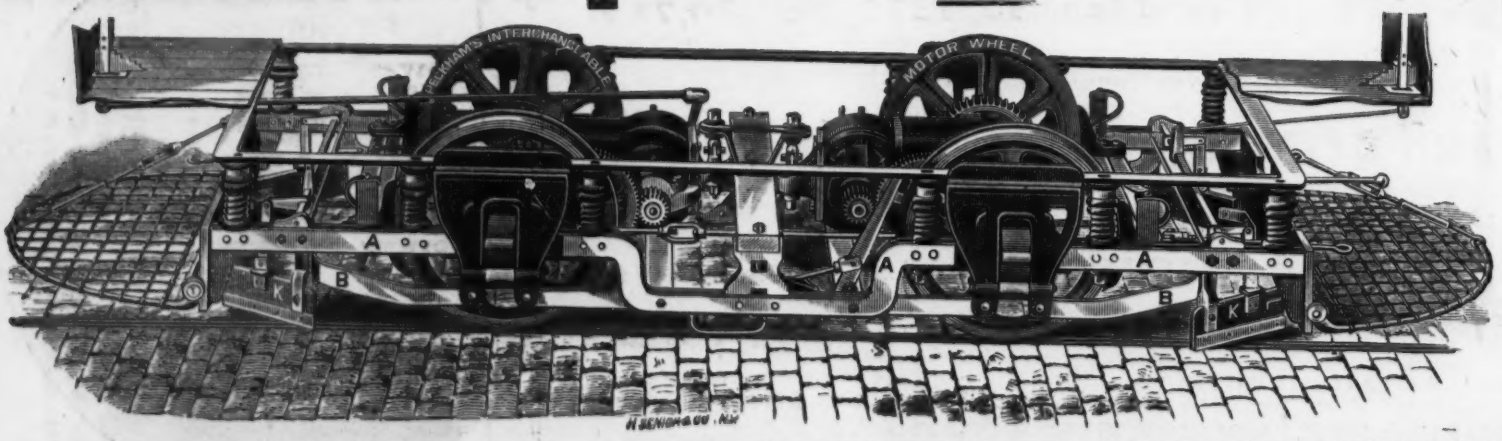


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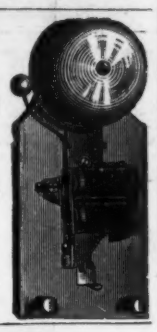

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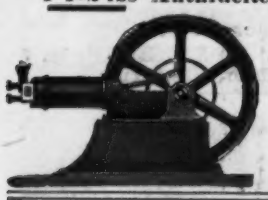

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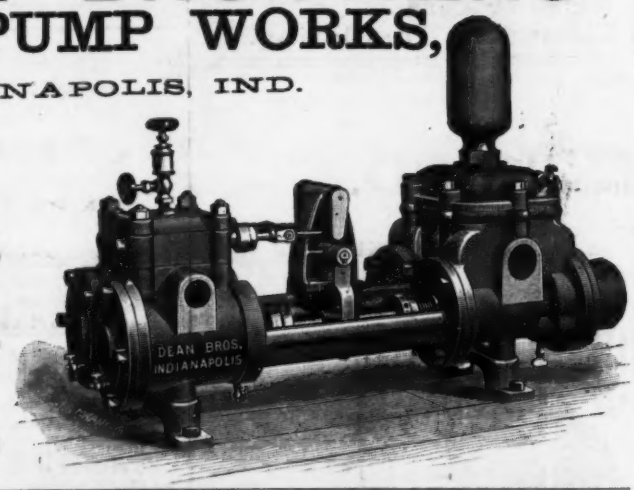


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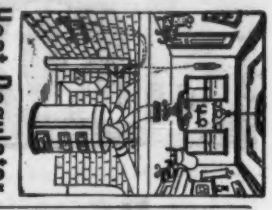

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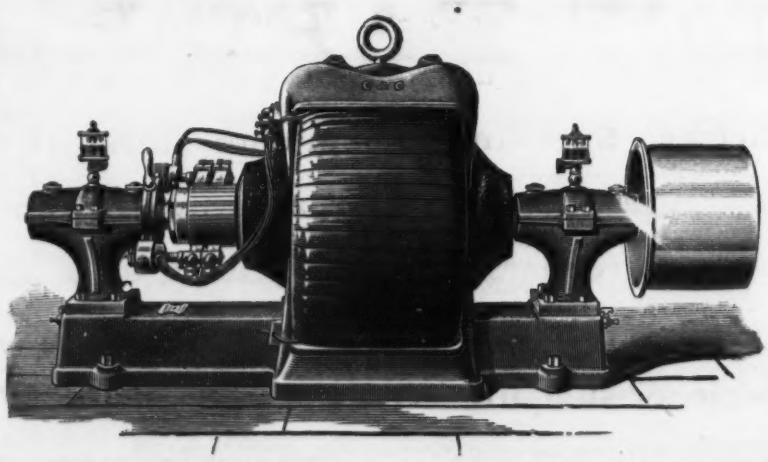

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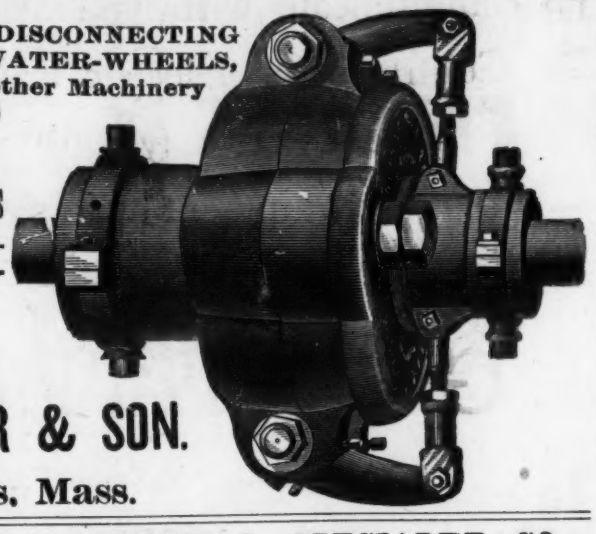

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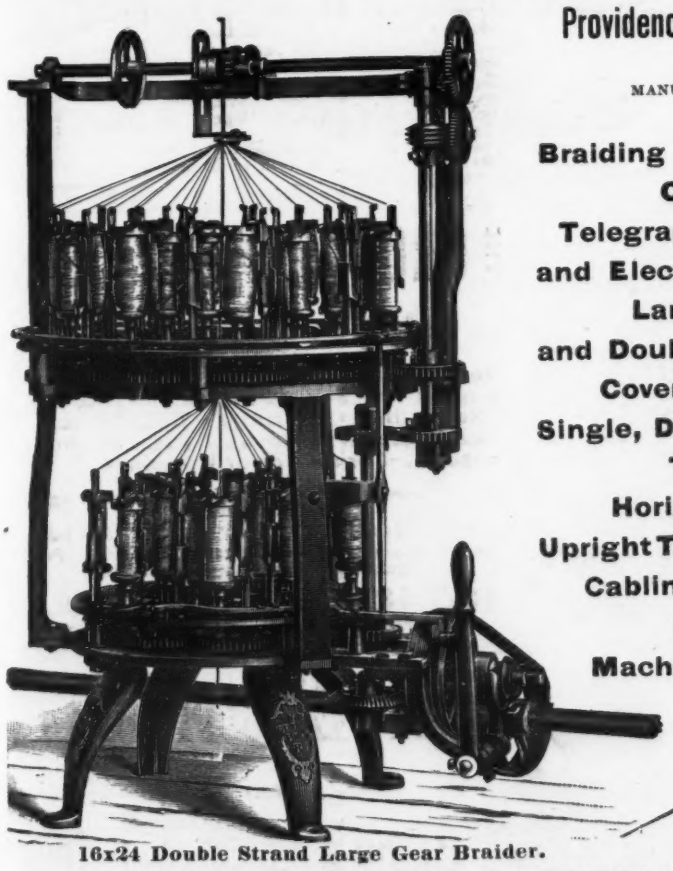

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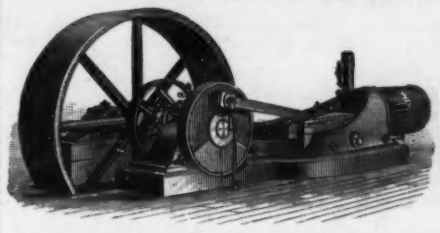

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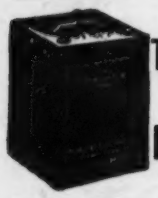

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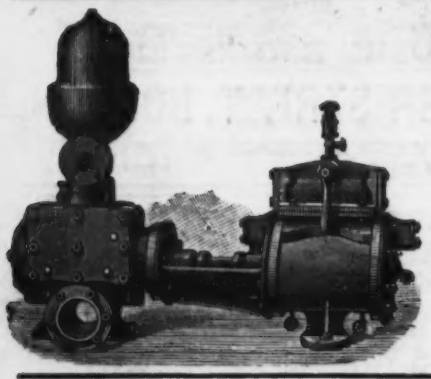

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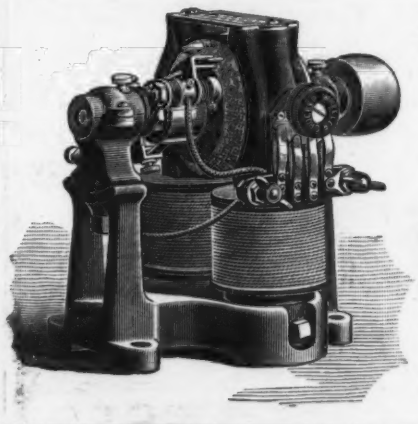

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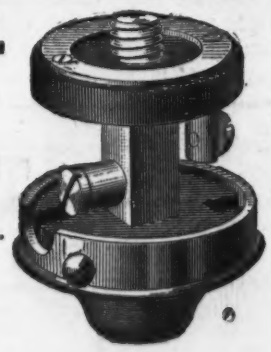

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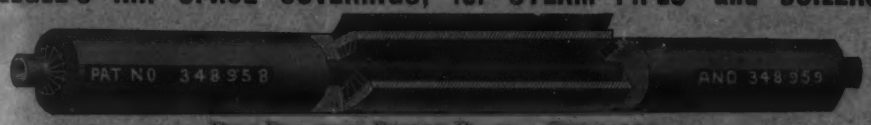


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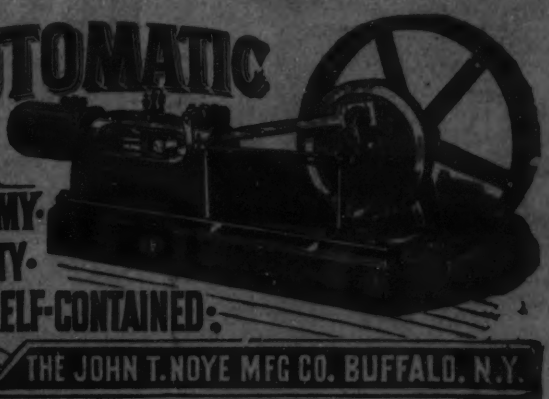

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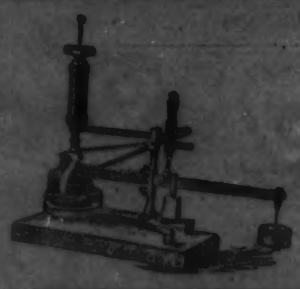

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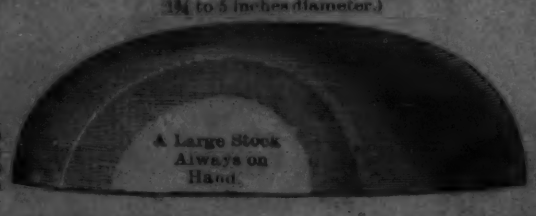


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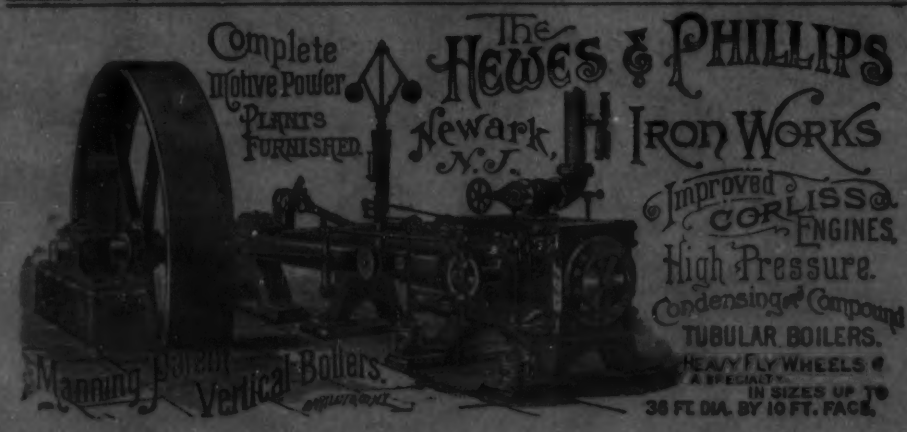
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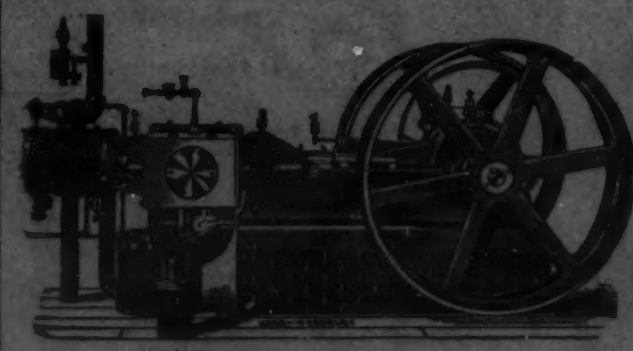

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